Vol. XVI.—No. 77] [July, 1913.

THE

MINERALOGICAL MAGAZINE

AND

Journal of The Mineralogical Society.

INSTITUTED FEBRUARY 3, 1876.

EDITED BY L. J. SPENCER, M.A.

ASSISTED BY A COMMITTEE OF COUNCIL.

Reproduced and Printed Photo-Litho Offset for
WM. DAWSON & SONS LTD.,
102, WIGMORE STREET, LONDON, W.1
1954
With permission of The Mineralogical Society

1913.

EXCERPT MINUTES OF COUNCIL MEETING.

Held in the Apartments of the Geological Society, June 18, 1912, *at* 5 *p.m.*

Dr. A. E. H. Tutton, F.R.S., Vice-President, in the Chair.

Mr. A. F. Hallimond and Mr. R. Bell were elected Ordinary Members f the Society.

The following changes in the list of Officers and Council were approved r recommendation to the Members of the Society:—

President. Dr. A. E. H. Tutton, in place of Prof. W. J. Lewis.

Vice-President. Dr. A. Hutchinson, in place of Dr. A. E. H. Tutton.

Ordinary Members of the Council. Messrs. F. H. Butler, J. P. De Castro, B. Kitto, and Prof. A. Liversidge, in place of Messrs. J. H. Collins, C. G. Cullis, J. W. Evans, and J. A. Howe.

On the motion of Dr. Fletcher, seconded by Dr. Prior, it was resolved hat the normal tenure of the office of President be three years.

The Address to be presented to the Royal Society was considered.

Resolved that newly elected Members be given the back numbers of he volume of the Journal current at the time of their election, and that he rule shall apply to Members elected since the beginning of the resent volume.

GENERAL MEETING.

Held in the Apartments of the Geological Society, June 18, 1912, *at* 5.30 p.m.

Dr. A. E. H. Tutton, F.R.S., Vice-President, in the Chair.

Twenty-seven Members were present.

The elections of Mr. A. F. Hallimond and Mr. R. Bell to the Ordinary Membership of the Society were confirmed.

The following papers were read:—

1. The isomorphism of the acid tartrates and tartar-emetics of potassium, rubidium, and caesium: by Mr. T. V. Barker.

2. On Topaz and Beryl from the granite of Lundy Island: by Mr. W. F. P. McLintock and Mr. T. C. F. Hall (p. 294).

3. On the Rathite group: by Mr. R. H. Solly.

4. On the minerals of the Nakhla meteorite: by Dr. G. T. Prior (p. 274).

5. Note on the occurrence of Cassiterite and Strüverite in Perak: by Mr. J. B. Scrivenor (p. 302).

Specimens were exhibited in illustration of the papers of Messrs. McLintock and Hall, and Mr. Scrivenor.

EXCERPT MINUTES OF COUNCIL MEETING.

Held in the Apartments of the Geological Society, November 12, 1912, *at* 5 *p.m.*

Professor W. J. Lewis, M.A., F.R.S., President, in the Chair.

Dr. Waldemar T. Schaller, Mr. Edward Sydney Simpson, and Mr. Arthur Henry Morgan were elected Ordinary Members of the Society.

The death of Prof. F. Zirkel, Honorary Member, was announced; and the resignation of Mr. A. L. Hall, Ordinary Member, was accepted.

The following were selected as the dates of meeting for the year 1913: Tuesdays, January 21, March 11, June 17, and November 11, the last to be the Anniversary Meeting.

The draft Annual Report of Council, submitted by the Secretary, was approved.

A vote of thanks was passed to Dr. G. F. Herbert Smith for sending notices of the meetings of the Society to 'Nature', 'The Geological Magazine', 'The Mining Journal', and 'Centralblatt für Mineralogie'.

ANNIVERSARY MEETING.

Held in the Apartments of the Geological Society, November 12, 1912, *at* 5.30 *p.m.*

Professor W. J. Lewis, M.A., F.R.S., President, in the Chair.

Thirty-one Members and five Visitors were present.

The elections of Messrs. W. T. Schaller, E. S. Simpson, and A. H. Morgan to the Ordinary Membership were confirmed.

The scrutineers reported that forty-seven voting-papers had been returned, and that the list as nominated by the Council was approved, namely:

President. A. E. H. Tutton, M.A., D.Sc., F.R.S.
Vice-Presidents. Prof. H. L. Bowman, M.A., D.Sc., F.G.S.
A. Hutchinson, M.A., Ph.D., F.G.S.
Treasurer. W. Phipson Beale, K.C., M.P., F.G.S., F.C.S.
General Secretary. G. T. Prior, M.A., D.Sc., F.R.S.
Foreign Secretary. Prof. W. W. Watts, M.A., Sc.D., F.R.S.
Editor of the Journal. L. J. Spencer, M.A., F.G.S.

Ordinary Members of Council.

T. V. Barker, M.A., B.Sc., F.C.S.
W. Barlow, F.R.S.
F. H. Butler, M.A., A.R.S.M., L.S.A. (Lond.)
T. Crook, A.R.C.Sc.I., F.G.S.
J. P. De Castro, M.A., F.I.C., F.C.S.
Rev. J. M. Gordon, M.A., F.G.S.
Sir Thomas H. Holland, K.C.I.E., D.Sc., F.R.S.
B. Kitto, F.I.C., F.G.S.
Prof. A. Liversidge, M.A., LL.D., F.R.S.
R. Pearce, Ph.D., F.G.S.
G. F. Herbert Smith, M.A., D.Sc., F.G.S.
H. H. Thomas, M.A., B.Sc., F.G.S.

The following ANNUAL REPORT OF COUNCIL was read:—

During the Session 1911–12 four meetings have been held (by kind permission) in the Apartments of the Geological Society, Burlington House, W., at which twenty-two papers were read. One number of the Journal (No. 75), containing nine papers, was published in May. For the loan of blocks for figures in this number the Society is indebted to Prof. Lewis, Dr. Tutton, and Dr. Hutchinson.

The balance-sheet of the year ending December 31, 1911, shows that the financial position of the Society is satisfactory. The assets (exclusive of the Library and stock of the Journal) amounted to £793 18*s.* 8*d.*, and the liabilities to £14 11*s.* 7*d.* The value of the Stock invested in the names of the Trustees of the Society was on that date £714 11*s.* 2*d.*, corresponding to £13 4*s.* 8*d.* for each Life-Member.

During the Session 1911–12 the Society has lost by death three Honorary Members (Prof. F. Zirkel, Prof. G. J. Brush, and Prof. S. Calderón) and two Ordinary Members, and by resignation two Ordinary Members. Two Honorary Members (Prof. V. Goldschmidt and Prof. C. Viola) and five Ordinary Members have been elected. The total number of members on November 11, 1912, was 135, of whom seventeen are Honorary. Of the Ordinary Members fifty-four have compounded for their annual subscription.

Sir Henry Miers and Mr. F. N. A. Fleischmann have been elected Trustees of the Society. At the celebration of the 250th Anniversary of the Royal Society the President, Prof. W. J. Lewis, acted as delegate for the Mineralogical Society and presented an address.

The Council has to congratulate the Society on its continued prosperity.

On the motion of Mr. Barker, seconded by Mr. De Castro, the Report was adopted.

A vote of thanks to the Council of the Geological Society for permission to meet in the Apartments of the Society was carried.

The dates of meeting for 1913, proposed by the Council, were approved.

The following papers were read:—

1. Ilmenite from the Lengenbach quarry, Binnenthal: by Prof. W. J. Lewis (p. 343).

2. An account of the minerals found in the Virtuous Lady mine, near Tavistock: by Mr. Arthur Russell.

3. Some graphical methods in crystallography and crystal-optics: by Dr. A. Hutchinson.

4. Labradorite from Co. Down: by Dr. A. Hutchinson and Mr. W. Campbell Smith (p. 267).

5. Apparatus for preparing thin-sections of rocks: by Dr. G. F. Herbert Smith (p. 317).

6. Calcite crystals from a water-tank: by Mr. Russell F. Gwinnell (p. 345).

Dr. J. Drugman exhibited plaster models of crystals, and Mr. Russell showed a fine series of specimens from the Virtuous Lady mine in illustration of his paper.

EXCERPT MINUTES OF COUNCIL MEETING.

Held in the Apartments of the Geological Society, January 21, 1913, *at* 5 *p.m.*

Dr. A. E. H. Tutton, F.R.S., President, in the Chair.

Prof. F. Wallerant and Prof. F. W. Clarke were elected Honorary Members of the Society.

Prof. Bundjirō Kotō, Prof. Austin Flint Rogers, and Mr. Harvey Collingridge were elected Ordinary Members of the Society.

Messrs. H. H. Thomas and W. Campbell Smith were elected Auditors of the Accounts for the year ending December 31, 1912.

The President, the General Secretary, and the Editor of the Journal, in conjunction with Dr. L. Fletcher and Sir Henry Miers, were appointed Editorial Committee for the Journal.

GENERAL MEETING.

Held in the Apartments of the Geological Society, January 21, 1913, *at* 5.30 *p.m.*

Dr. A. E. H. Tutton, F.R.S., President, in the Chair.

Thirty-one Members and one Visitor were present.

The elections of Prof. F. Wallerant and Prof. F. W. Clarke as Honorary Members, and of Prof. B. Kotō, Prof. A. F. Rogers, and Mr. H. Collingridge to the Ordinary Membership of the Society were confirmed.

The following papers were read:—

1. Note on the determination of the optic axial angle of crystals in thin-section: by Mr. H. Collingridge (p. 348).

2. Optical activity and enantiomorphism of molecular and crystal structure: by Messrs. T. V. Barker and J. E. Marsh.

3. Graphical determinations of angles and indices in zones: by Dr. G. F. Herbert Smith (p. 326).

4. On the Goldschmidt apparatus for cutting models of crystals: by Dr. J. Drugman.

5. On a nodule of Iron-pyrites: by Prof. H. L. Bowman.

Papers (2), (3), and (4) were illustrated by lantern slides. Mr. F. N. A. Fleischmann exhibited a carved specimen of amethyst, and Mr. E. Hopkins showed scales and weights used in Bombay for weighing pearls.

EXCERPT MINUTES OF COUNCIL MEETING.

Held in the Apartments of the Geological Society, March 11, 1913, *at* 5 *p.m.*

Professor H. L. Bowman, D.Sc., Vice-President, in the Chair.

The audited Balance-sheet for the year ending December 31, 1912, was approved, and instructions were given for it to be inserted in the Minutes and to be published in the next issue of the Journal.

Prof. H. L. Bowman was appointed as Delegate to represent the Society at the International Geological Congress to be held in Canada this year.

Letters were read from the recently elected Honorary Members, Prof. F. Wallerant and Prof. F. W. Clarke.

GENERAL MEETING.

Held in the Apartments of the Geological Society, March 11, 1913, *at* 5.30 *p.m.*

Professor H. L. Bowman, D.Sc., Vice-President, in the Chair.

Twenty-two Members and two Visitors were present.

The following papers were read:—

1. The mineral collection of Thomas Pennant (1726–1798): by Mr. W. Campbell Smith (p. 331).

2. The minerals and mineral-localities of Montgomeryshire: by Mr. Arthur Russell.

3. A new stereographic protractor: by Dr. G. F. Herbert Smith.

4. A (sixth) list of new mineral names: by Mr. L. J. Spencer (p. 352).

Dr. A. Hutchinson exhibited the new 'universal apparatus' for optical determinations devised by him, and Mr. Arthur Russell mineral-specimens from Montgomeryshire in illustration of his paper.

ABSTRACT OF RECEIPTS AND PAYMENTS FROM JANUARY 1 TO DECEMBER 31, 1912.

Receipts.	£ s. d.	£ s. d.
Balance from 1911		35 4 6
Subscriptions—(1) current	51 8 0	
(2) arrears	10 10 0	
		61 18 0
Entrance fees and compositions		18 18 0
Sale of publications—		
By Publishers	37 6 0	
By G. Savigar	1 12 0	
		38 18 0
Dividends on Stock		22 6 9
		£177 5 3

Payments.	£ s. d.	£ s. d.
Printing Magazine (No. 75)	32 7 6	
Authors' copies	5 11 3	
Illustrations	1 7 6	
		39 6 3
Miscellaneous Printing—		4 11 0
Editor's Honorarium (1911)		10 10 0
G. Savigar for care of stock of Publications (1911)		1 1 0
Porter's Fee (1911)		1 0 0
R. Jones, manipulating lantern		5 0
Postage and Parcels—		
Magazine	3 6 10	
G. Savigar (1911)	6 1	
Hon. Secretary (1911)	5 8	
Hon. Treasurer (1911)	9 5	
		4 8 0
Oxford University Press, Copies of Address to Royal Society		1 8 0
Investments—		
Dividends	21 19 3	
Two Life Compositions	31 10 0	
Broker's fee on above	7 6	
		53 16 9
Broker's charges of transfer to new trustees		0 12 0
Bank Charges		1 0
Balance at Bank	59 15 4	
„ in Office	10 11	
		60 6 3
		£177 5 3

Examined and compared with the vouchers, and found correct.
11 *February*, 1913.

(*Signed*) HERBERT H. THOMAS, W. CAMPBELL SMITH } Auditors.

BALANCE SHEET.

DECEMBER 31, 1912.

LIABILITIES.	£	s.	d.
Owing for Editor's Honorarium (1912)	10	10	0
,, G. Savigar for care of stock of Publications (1912)	1	1	0
,, Do. for postage (1912)		8	8
,, Hon. Secretary for postage (1912)		8	9
,, Do., fee paid for lantern		2	6
,, Hon. Treasurer for postage (1912)		7	7
,, Williams & Strahan for Printing, &c.	3	8	9
Excess of assets over liabilities	835	11	11
	£851	19	2

ASSETS.	£	s.	d.	£	s.	d.
Balance at Bank	59	15	4			
,, in Office		10	11			
				60	6	3
Consols (£998 4*s.* 7*d.*, valued at £74)				738	14	0
Sale of Publications (1912)—						
Owing from Publishers	40	8	0			
,, G. Savigar	2	0	11			
				42	8	11
Arrears of Subscriptions (estimated good)				10	10	0
				£851	19	2

The number of Life Members on December 31 was fifty-four.

The stock of Publications and the value of the Library are not included in the above assets. (*Signed*) W. P. BEALE,
Hon. Treasurer.

THE MINERALOGICAL MAGAZINE

AND

JOURNAL OF

THE MINERALOGICAL SOCIETY.

No. 77. JULY, 1913. Vol. XVI.

On varieties of Zirkelite from Ceylon.[1]

By G. S. Blake, A.R.S.M., B.Sc., F.C.S.

With crystallographic notes,

by G. F. Herbert Smith, M.A., D.Sc., F.G.S.
Assistant in the Mineral Department of the British Museum.

[Read June 23, 1911.]

THIS paper deals with various specimens received at the Imperial Institute from Ceylon. Some of these specimens were obtained by Mr. A. K. Coomaraswamy at Walaweduwa, in the Bambarabotuwa district of the Sabaragamuwa province, during the course of the Ceylon Mineral Survey. Walaweduwa is a little to the north of the Bambarabotuwa locality where thorianite has been found in considerable abundance. Mr. Coomaraswamy also found specimens in the upper part of the Alupola Oya, a stream in the same district. A chemical examination of these specimens showed that titanium dioxide, zirconia, thoria, lime, and iron oxide were the chief constituents. This, taken in conjunction with their

[1] Communicated by permission of the Director of the Imperial Institute. A brief mention of this mineral has already been made, under the name Zirkelite, in 'Ceylon: Report on the results of the Mineral Survey in 1904–5,' Colonial Reports, Miscellaneous, No. 37, London, 1906, pp. 29 and 40.

physical characters, indicated that they belonged to the species zirkelite a species which had been previously found at Jacupiranga, São Paulo Brazil, and described in this magazine by Dr. E. Hussak and Dr. G. T Prior.[1]

Other specimens of zirkelite were collected at a later date from various consignments of refuse gem-gravel which had been obtained from alluvial deposits in different parts of southern Sabaragamuwa, and sent to the Imperial Institute for examination. The heavy minerals consisted chiefly of zircon, tourmaline, corundum, and spinel; and several rare earth minerals were also present. The area from which these gravels were obtained includes also the Bambarabotuwa district; but as no definite locality can be assigned to them, it will be convenient to refer to them as being from the 'gem-gravels of southern Sabaragamuwa', in order to distinguish them from the more precisely localized specimens sent by Dr. Coomaraswamy.

Physical Characters.

The specimens received from the Bambarabotuwa district are coarse grains mostly of irregular shape and show very rough surfaces. None of the grains weigh more than about a gram. They are brownish-black in colour, and their specific gravity ranges from 4·72 to 5·22. Those obtained from the 'gem-gravels of southern Sabaragamuwa' are much larger, weighing from 5 to 15 grams. In general appearance there is little to distinguish the latter from the Bambarabotuwa specimens, but their specific gravity is lower, and varies from 4·3 to 4·6. The colour of the streak is chocolate-brown, and is of a slightly darker shade in the uranium-rich than in the thorium-rich varieties. The hardness is $5\frac{1}{2}$ to 6. The fracture is sub-conchoidal, and the lustre is sub-metallic to resinous.

The few small crystals found amongst the material from the Bambarabotuwa district show six-sided prisms terminated by basal planes. Some of them exhibit a slight tendency to cleave parallel to the basal plane. From the 'gem-gravels of southern Sabaragamuwa' crystals of very various habit and irregular development have been obtained. Some of the larger of these exhibit what may perhaps be regarded as complex twinning

[1] E. Hussak and G. T. Prior, 'Lewisite and zirkelite, two new Brazilian minerals,' Mineralogical Magazine, 1895, vol. xi, pp. 80–88. G. T. Prior, 'On the chemical composition of zirkelite,' Mineralogical Magazine, 1897, vol. xi, pp. 180–183.

forms: the best of them were submitted to Dr. G. F. Herbert Smith for crystallographic examination (p. 314).

In thin-sections examined under the microscope the material was for the most part opaque, but occasionally showed reddish-brown, translucent specks and small patches.

Chemical Composition.

On heating in the blowpipe flame the mineral decrepitates. The powdered mineral is slowly attacked by hydrochloric acid, and if excess of acid is maintained all but 2 or 3 per cent. passes into solution on the addition of cold water. There is a decided tendency, however, for titanic acid mixed with zirconium hydroxide to separate if the chlorides become dry. The powdered mineral is very readily decomposed by hydrofluoric acid, and when subsequently converted into sulphate by heating with sulphuric acid, complete solution is effected on the addition of water.

The plan adopted for the analysis of the mineral is based on the following methods:—

(1) Separation of calcium and magnesium by precipitation of the hydroxides of the other metals with ammonia in the presence of ammonium chloride.

(2) Precipitation of the rare-earth metals as oxalates by means of ammonium oxalate from an acid solution of the chloride.

(3) In the filtrate from (2) the separation of zirconium and titanium from iron with sodium thiosulphate.

The details of the methods employed are as follows:—

Solution was generally effected by treating one or two grams of the powdered mineral with hydrofluoric acid and removal of the volatile acid by evaporation with sulphuric acid. On adding cold water a perfect solution was obtained. Hydrochloric acid was added and then ammonia and the precipitate filtered off. This was re-dissolved and the operation repeated. The combined filtrates were evaporated, and lime and magnesia estimated in the usual way.

The hydroxides dissolved in slight excess of hydrochloric acid were then poured into a hot solution of ammonium oxalate and the precipitate of oxalates of thorium, cerium and yttrium groups filtered off after some hours standing. This after ignition was treated with 50 per cent. sulphuric acid, and the sulphates then converted into chlorides.

The thorium was separated from other rare-earth metals by double precipitation with sodium thiosulphate, then re-precipitated with am-

monium oxalate to ensure the complete separation from any zirconium and titanium which may have been carried down with the oxalates first precipitated. The combined filtrates from this separation were treated with bromine water and ammonia. Hydroxides of zirconium, titanium, and iron were thus precipitated, together with ammonium uranate. On the addition of ammonium carbonate all the uranium was obtained in solution, together with a little zirconium, &c. By boiling this solution for a few minutes the zirconium, &c., was precipitated. The uranium in the filtrate was estimated as uranoso-uranic oxide.

The precipitate containing the zirconium, titanium, and iron was dissolved as chloride, and the zirconium and titanium separated with sodium thiosulphate from the iron, which was afterwards precipitated with ammonia.

The titanium and zirconium were finally weighed as oxides. In order to estimate the titanium these oxides were dissolved in hydrofluoric acid and subsequently converted into sulphates as previously described. An aliquot portion of the solution of the sulphates was then titrated colorimetrically in comparison with a standard solution of pure titanium sulphate. Hydrofluoric acid must be completely removed or the results are untrustworthy.

The difference between the percentage of oxides calculated from the results of analysis and the percentage of titanium dioxide obtained colorimetrically is recorded as zirconium dioxide. No alumina nor niobic and tantalic oxides were found by fusion with caustic potash.

The results of analysis show that there are three main varieties of the mineral, in which there are considerable differences in the percentages of thorium and uranium :—

(1) A variety rich in thoria, with a specific gravity of about 5·1. This contains about 20 per cent. of thorium dioxide and 1 per cent. of uranium oxide (analyses I–III).

(2) A variety poorer in thoria, with a specific gravity of 4·4. This contains about 8 per cent. of thorium dioxide and 2 to 5 per cent. of uranium oxide (analyses IV and V).

(3) A variety containing little or no thoria, but as much as 15 per cent. of uranium oxide. Specific gravity 4·4 (analysis VI).

The following table shows the variation in composition of the specimens analysed, I–III being of material from the Bambarabotuwa district and IV–VI of material from the 'gem-gravels of southern Sabaragamuwa'. Under VII Dr. Prior's analysis of zirkelite from Brazil is quoted for comparison.

	I.	II.	III.	IV.	V.	VI.	VII (Prior).
ThO_2	20·17	20·44	18·78	8·33	8·51	0·23	7·31
U_3O_8	—	1·06	0·65	4·66	2·08	14·31	1·40[1]
ZrO_2	—	30·73	32·56	34·19	32·64	35·27	52·89
TiO_2	—	29·50	30·95	36·26	36·06	34·87	14·95
Ce_2O_3	1·44	2·68	1·40	0·32	0·83	—	2·52
La_2O_3	2·17					—	—
Di_2O_3						—	—
Y_2O_3	0·96	1·08	0·40			—	0·21
Al_2O_3	—	—	—	—	2·26	—	—
FeO	—	4·07	4·42	4·72	4·65	3·73	7·72
MnO	—	0·03	—	—	—	—	—
CaO	—	6·87	6·78	8·55	9·35	8·18	10·79
MgO	—	2·34	3·04	1·33	1·08	1·96	0·22
PbO	—	0·38	—	—	—	0·44	—
H_2O	—	0·46	1·05	1·70	1·74	1·68	1·02
Total	—	99·64	100·03	100·06	99·20	100·67	99·03
Sp. gr.	5·2	5·0–5·1	4·72	4·47	4·32	4·40	4·741

No definite formula can be deduced from these analyses.

Examination for gaseous Constituents.

Only the high thorium variety was examined. A 20-gram sample of the coarsely ground mineral was introduced into a closed tube of Jena glass, and the tube attached to a Töpler pump. After pumping out the air, the sample was heated and the gas collected. It was then re-ground, mixed with powdered acid potassium sulphate, and again heated till decomposed. By this means a further evolution of gas was obtained, and this portion contained most of the helium.

The total volume of gas after freeing it from sulphur dioxide was 134·9 c.c. at 0° C. and 760 mm. pressure, or 6·7 c.c. per gram of the mineral. An analysis showed it to have the following composition:—

	Volume.	Percentage Composition.
Carbon dioxide ...	54·17 c.c.	40·2
Hydrogen	13·74 „	10·2
Nitrogen	47·12 „	34·9
Helium	19·86 „	14·7
	134·89 „	100·0

[1] UO_2.

The gas, freed from carbon dioxide, hydrogen, and nitrogen, was examined spectroscopically by Mr. A. Fowler, F.R.S., who stated that the lines of helium were present, but that no argon could be detected. A determination of 15·1 c.c. of the gas gave a density of 3·74 at 0° C. and 760 mm. pressure.

The amount of helium in zirkelite is about one-tenth that found in thorianite, and stands roughly in proportion to the amounts of uranium oxide found in the minerals.

Crystalline Form (G. F. H. S.).

Early in May, 1906, a twin-crystal of zirkelite possessing comparatively brilliant faces was entrusted to the writer by the Director of the Imperial Institute for measurement on the three-circle goniometer in the Mineral Department of the British Museum; three well-developed crystals were afterwards discovered and were also measured on the same instrument. These crystals had been picked out from the 'gem-gravels of southern Sabaragamuwa' (p. 310), and they are identical in specific gravity and streak with the larger water-worn crystals found in the same samples of material (analyses IV–VI, p. 313). It may, therefore, be assumed with some confidence that the crystals here described, like the larger crystals actually analysed, belong to the mineral species zirkelite.

Of the four crystals, two are simple and two are twinned. The symmetry is hexagonal, and six forms in all have been observed:—

c(0001), varies in relative size; reflections distinct.

d$(10\bar{1}2)$, *e*$(20\bar{2}3)$, both small and rare; reflections faint.

r$(10\bar{1}1)$, large; smoother than *s* and reflections sometimes distinct; plane of twinning.

s$(20\bar{2}1)$, large, striated parallel to the axis of the zone [*crs*]; reflections blurred.

m$(10\bar{1}0)$, large but not often found; so rough and rounded that definite reflections were rare.

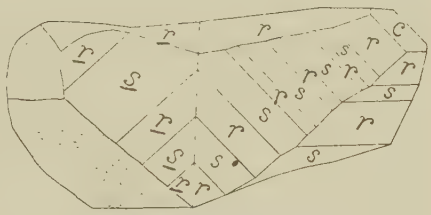
There is considerable oscillation between *r* and *s*, as represented in the accompanying text-figure.

Crystal 1 is a hexagonal plate in shape with the forms *crsm* and about 6 mm. across. It is much worn and no measurable reflections were obtainable except from the basal planes.

Crystal 2 is roughly a hexagonal prism in shape and about 8 mm. in

length. The forms present are *crs*, the last of which is largely developed with some oscillation and gives rise to the prismatic appearance.

Crystal 3 (text-fig.) is a twin, one individual of which is better developed than the other. The whole of the observed forms are present on this crystal. The basal plane is relatively small but gives distinct reflections, and the faces of the form *r* are unusually brilliant. The figure has been drawn directly from the crystal as viewed through the microscope; the stippled parts of the figure indicate the fractured surfaces. The extreme width in the position depicted is about 7 mm. The angle between the faces *cc* of the two individuals is 71° 6′, corresponding to an angle between the axis of twinning and the crystallographic axis of 54° 27′. It will be noticed that the faces in the zone containing the pole of twinning are sensibly smaller in size.



Twinned crystal of Zirkelite from Ceylon.

Crystal 4 shows the forms *crsm* and is also a twin, although the angle *cc*, 112° 30′ gives for the angle between the twinning pole and the basal plane a value 56° 15′, which differs considerably from that found for *cr*. The individuals, owing to the large development of the forms *sm*, are prismatic in shape and the basal plane is also prominent. The two individuals are 5 and 4 mm. in length, and 4 and 2 mm. in section respectively.

Measurements from $c(0001)$.

Hexagonal; $a : c = 1 : 1{\cdot}1647$.

Forms.	Calculated Values.	Observed Means.	No.	Limits of Observations.
$d(10\bar{1}2)$	33° 55′	34° 10′	3	33° 15′—34° 45′
$e(20\bar{2}3)$	41 53	42 25	3	41 30—43 31
$r(10\bar{1}1)$	*	53 22	23	52 0—54 30
$s(20\bar{2}1)$	69 36	69 16	17	68 30—69 55
$m(10\bar{1}0)$	*	90 0	10	89 0—91 0

The azimuthal angles approximate to 60°, but differed in the extreme limit as much as $1\frac{1}{2}$° from that value. In view of the fact that the blur of light reflected from some of the faces extended over as much as 5° such discrepancy is to be expected.

The crystals are brownish-black, and their lustre is sub-metallic to resinous. Microscopic splinters are yellowish-brown in colour and optically isotropic. In these characters the crystals, though much larger, resemble closely those described by Dr. E. Hussak [1] from Brazil, to which he and Dr. G. T. Prior gave the name zirkelite. The latter are flattened octahedra in form and frequently display spinel-like twins. They were too much striated for goniometrical measurements, but were supposed from their habit and optical characters to belong to the cubic system. The present crystals, on the other hand, have undoubtedly hexagonal or lower symmetry, although minute fragments are isotropic, as seems to be generally the case with crystallized minerals containing rare earths whatever the morphological symmetry. It may be noticed that the value obtained for *cr* above approximates to the angle (100) : (111) in the cubic system (54° 44′). The Brazilian crystals, which were presented to the British Museum by Dr. Hussak, and are a part of those on which the investigation by him and Dr. Prior was carried out, display apparently cube faces, deeply striated, which have only one pair of opposite coigns truncated by brilliant triangular faces. This development suggests that their morphological symmetry is not strictly cubic, but possibly hexagonal or rhombohedral. Measurements of the angle between the latter faces and the cube faces are very untrustworthy, but approximate to 55°, which is higher than the value obtained for *cr* above, but not so much as to preclude the possibility that the morphological symmetry is the same in both cases and the variations in the angles are merely due to isomorphous changes in the chemical composition.

The large crystals which have been analysed by Mr. G. S. Blake are so water-worn that it is difficult even to conjecture what their morphological symmetry may be.

[1] E. Hussak and G. T. Prior, Mineralogical Magazine, 1895, vol. xi, pp. 86–88. Preliminary observations were published by Dr. Hussak in Tschermak's Min. Petr. Mitt., 1895, vol. xiv, pp. 408–410.

Description of an apparatus for preparing thin-sections of rocks.[1]

By G. F. Herbert Smith, M.A., D.Sc., F.G.S.

Assistant in the Mineral Department of the British Museum.

[Read November 12, 1912.]

EARLY in the year 1912 extensive modifications were introduced in the apparatus for slitting rocks, and for grinding and polishing thin-sections in the Mineral Department of the British Museum, the whole of the alterations and additions being carried out to my designs by Messrs. Plume[2] and Parry, 47 Old Compton Street, London, W. The changes made were chiefly in the means for holding the specimen or section during the operations; much of the actual machinery remained unaltered, and some of it dates back to the initial installation, upwards of forty years ago. It may not, therefore, be without interest if a brief description of the history of the installation be included with the description of the present apparatus.

That the study of thin-sections was essential for a satisfactory investigation of the structure of substances was recognized almost as soon as microscopes suitable for the purpose were available, but for want of a proper adhesive medium really transparent sections were at first not practicable. It was William Nicol, to whom science owes an immense debt of gratitude for his invention of the prism that bears his name, who devised the process which is in all essentials the same as that practised to-day. He probably made the discovery in 1828, in connexion with his prism, of the valuable properties of Canada balsam, and shortly afterwards applied this resin to the preparation of thin-sections, and found it to give excellent results. Among the earliest sections made by him were a series which were utilized by Henry Thornton Marie Witham[3] in

[1] Communicated by permission of the Trustees of the British Museum.

[2] I much regret to state that Mr. J. A. Plume, the head of the firm, under whose personal supervision the apparatus was constructed, died suddenly on February 15, 1913.

[3] H. T. M. Witham, 'Observations on fossil vegetables,' 1831, Edinburgh, William Blackwood; London, T. Cadell. He acknowledges on p. 4 his indebtedness to Nicol, and on pp. 45–47 gives verbatim the latter's description of the method used. The description is quoted in full in a notice of the book appearing in the Edinburgh Journal of Science, 1831, vol. v, pp. 183–189.

an investigation of the minute internal structure of fossil wood. Henry Clifton Sorby was the first to make use of thin-sections for the study of rocks, in 1849, in the course of an investigation of the microscopical structure of calcareous grit,[1] but the new means of research thus opened out met with little appreciation and much ridicule among geologists, even after the publication, in 1858, of his important paper on the microscopical structure of crystals,[2] and it did not come into general use until about 1870, from which year may be said to date the renaissance of petrology. In his book on 'The Founders of Geology',[3] Sir Archibald Geikie pictures Sorby as realizing the importance of a study of thin-sections after seeing (in 1856) the cabinet of sections belonging to Alexander Bryson, which included all those left by Nicol. As Professor J. W. Judd points out in an obituary notice[4] of Sorby, the latter had, as a matter of fact, commenced making sections several years before. Professor Judd goes on to remark, 'I am not aware, however, that Nicol anywhere claims to have invented the method.' The lapidary's art, of course, goes back far beyond Nicol, and Brewster[5] was studying sections of minerals in 1816; but without the use of Canada balsam as the mounting medium, for which we have to thank Nicol, thin-sections, particularly of rocks in which the component substances vary so much in character, would not have been feasible.

The earliest sections made in the British Museum were those prepared about the year 1860 by M. H. N. Story-Maskelyne, the Keeper of Minerals at that time, in the course of his investigations of the composition and constitution of certain meteorites.[6] These sections, which are still preserved in the Mineral Department, would be accounted somewhat thick if judged by modern standards. They were made without any elaborate apparatus or machinery; fragments or pieces resulting when the specimens were sawn in order to expose a plane surface, which was afterwards polished and etched so as to reveal the character of the structure, were polished and fixed to a piece of thick glass, and rubbed down by hand on a plate until sufficient transparency was obtained. Many of the sections were considerably larger in area than is customary now, and the glass to which they were fixed was much thicker than the slips used to-day. This process was, of course, tedious and laborious,

[1] H. C. Sorby, Quart. Journ. Geol. Soc., 1851, vol. vii, pp. 1–6.
[2] H. C. Sorby, Quart. Journ. Geol. Soc., 1858, vol. xiv, pp. 453–500.
[3] 1st edition, 1897, p. 278; 2nd edition, 1905.
[4] J. W. Judd, Geol. Mag., 1908, vol. v, p. 197.
[5] Sir D. Brewster, Trans. R. Soc. Edinburgh, 1817, vol. viii, p. 371.
[6] M. H. N. Story-Maskelyne, Phil. Trans., 1870, vol. clx, p. 189.

and it had the further disadvantage of entailing great waste of material. It was therefore ultimately decided to acquire suitable lapidary's machinery, and in March, 1870, an installation both for slitting and for grinding was supplied by Messrs. C. & F. Darker, a firm of optical lapidaries and scientific instrument makers, of 9 Paradise Street, Lambeth, London, S.E., now no longer existing. For a few years William Lunan, a lapidary, who had a small shop in Museum Street, Bloomsbury, London, W.C., near the British Museum, and who was not on the Museum staff, was employed to do whatever work was required, but he gave it up in 1874, as he found it to interfere adversely with his own business. By that date it had become evident that the quantity of section work was such that it was desirable the lapidary should be on the permanent staff of the Museum, and accordingly Thomas John William Ryley, who had entered the service of the Trustees in 1872, was appointed lapidary. The work was done at that time under what would seem to us, accustomed to the conveniences of the present day, intolerable difficulties. The workshop was a room in the basement of the old building at Bloomsbury, and was illuminated by such light as was not cut off by a brick wall which was within a few yards of the window, and the top of which was beyond the line of vision from within the room. The precautions against fire would not allow of the use of a flame or artificial light, and every section had to be mounted in a distant room where a spirit lamp was permitted on a slate slab. Upon the transference in 1881 of the Natural History Departments to the building in the Cromwell Road, South Kensington, which had been erected to receive them, the plant was at first placed in a room in the north-east corner of the basement, but the position was not found suitable, mainly owing to the want of proper heating arrangements at that time, and it was shortly afterwards removed to the present lapidary's shop, which was formed by screening off a portion of a corridor near the studies of the Mineral Department in the south-east corner of the basement. Beyond the replacement from time to time of discs, laps, and worn-out parts no change was made in the plant till 1904, when electromotors replaced the machinery for hand-driving in the case of both the slitting and the grinding machines. It was found more convenient to install two separate motors, rather than to attempt to rearrange the apparatus and benches within the narrow space of the shop. Ryley retired in 1911, and was succeeded as lapidary by Thomas Vincent, an attendant in the Mineral Department.

I will first describe the apparatus as it was previous to the recent

changes. The slitting machinery itself has not been altered. It consists of a disc, 10 inches (25 cm.) in diameter, mounted on a vertical spindle and driven by a motor under the bench. The disc is held between collars, $3\frac{1}{2}$ inches (9 cm.) in diameter, of which the upper is visible in fig. 1, and the lower is hidden by the disc. They are tightened by the nut *a*. The specimen-holder originally rotated round a vertical spindle, fixed firmly to the bench in about the same position as the present spindle (*b*, fig. 1), by means of a loosely fitting collar, and was maintained at the proper height to suit the work in hand by means of a smaller collar clamped to the spindle. To the short stout arm forming part of the collar of the specimen-holder a long wooden jaw was screwed, the total length from the axis of rotation being about $15\frac{1}{2}$ inches (39·5 cm.). Two screw bolts, square-shaped towards the head, passed through holes in the jaw, which were similarly shaped so as to fit the bolts tightly, and passed also loosely through round holes in the shorter piece of wood forming the other jaw; two wing-nuts riding on the screws tightened the jaws. The specimen-holder was therefore movable round the fixed spindle by means of the loose collar referred to. A weight connected to the end of the arm by means of a piece of string passing over a small pulley-wheel, fitted on the edge of the bench, drew the specimen on to the slitting disc.

The flat face of the small piece cut off from the rock in the manner described was ground smooth on the grinding-lap, the piece being held in the hand, and finished on a brass plate. This face was fixed by means of Canada balsam in the usual way to a microscope glass-slip, 3 by 1 inches and $\frac{1}{16}$ inch thick (76 by 25 by 1·5 mm.), of the kind customary in this country. If the piece were thick, the glass-slip was set in the jaws, and as thin a section as practicable cut from the piece by the slitting disc. Further reduction in the thickness was effected by holding the glass-slip in the fingers and applying the section to the surface of the rotating lap. The surface of the lap was made slightly convex, because it was found by experience that otherwise the edges of the section were ground thinner than the centre, or even possibly worn away altogether. When the section was thin enough the second face was finished off as before on the brass plate, and a small cover-glass was attached with Canada balsam.

When I came to examine the plant in 1911 several obvious defects called for remedy. In the case of the slitting machine, the collar of the specimen-holder had become so worn that it no longer fitted the upright spindle, about which it turned, with even approximate tightness, and at

the point of the arm where the specimen was clamped there was over $\frac{1}{2}$ inch (1 cm.) play. The cut was therefore never flat, and it was impossible to maintain uniformity of thickness when slitting the second face of the section; instead, a wedge of irregularly increasing thickness was cut, and a considerable amount of unnecessary grinding entailed. A further difficulty was presented by the way the jaws were tightened. The screw-bolts were not rigidly attached to the longer jaw, and the round holes in the other were more than a little larger than the diameter of the bolts. Consequently, in the final tightening there was a tendency for one jaw to shear with respect to the other, and the glass-slip, if that were being held, became distorted and the Canada balsam loosened, with the result that the piece of rock was flicked off and had to be refixed. The method of using the grinding-lap was very unsatisfactory, the want of a mechanical section-holder being severely felt. The glass-slips used were only $\frac{1}{16}$ inch (1·5 mm.) in thickness, and it was quite impossible in grinding the second face of the section for the lapidary to prevent the tips of his fingers coming into contact with the lap; they were, in consequence, often torn, and the work was at times at a standstill until the lapidary's fingers were healed. Moreover, full use could not be made of the electric power, because at any point beyond moderate speeds the section was inevitably wrenched out of the fingers.

An entirely new specimen-holder was designed for the slitting machine. The apparatus is illustrated in fig. 1, as arranged for cutting the second face of a section. The holder is similar to the old one, but differs from it in several important details. The spindle (*b*), which is of steel, is no longer rigidly fixed to the bench, but may turn between fixed centres. The bearing surfaces are conically shaped, and to facilitate lubrication at each end the upper cone is pointed, and the lower one recessed. The screw (*c*) at the top allows of the fit being made as tight as may be desired, while the locking-nut (*d*) prevents any accidental loosening; should any of the bearing surfaces wear in the course of time it is only necessary to tighten the screw up slightly. The holder consists of two parts—the jaws and a rectangular frame. The latter is attached to the spindle by two collars (e_1, e_2), which are clamped by screws working into a U-shaped groove running the length of the spindle. The frame (*f*) has two sets of vertical slots, into either of which the tongue of the iron arm carrying the jaws may be fixed by the nut at the back; it is usually placed in the lower set as in fig. 1. A piece of hard wood, which forms one jaw, is screwed to the bar. A pair of screws (g_1, g_2) are tapped and riveted to the arm, at a distance of $5\frac{1}{2}$

inches (14 cm.) apart and at right angles to it. On each rides a nut, $2\frac{1}{2}$ inches (6·5 cm.) in length. Little more than half is visible in fig. 1. One half, in shape a smooth cylinder of $\frac{1}{2}$ inch (13 mm.) diameter, passes into the second jaw, which is drilled with slightly larger holes for the purpose. To prevent distortion the second jaw has an iron frame at the back—not a bar, to save weight. By this arrangement of carrying the second jaw, there is no tendency for it to shear at the moment of tightening. The spindle has been made of ample length, so as to admit

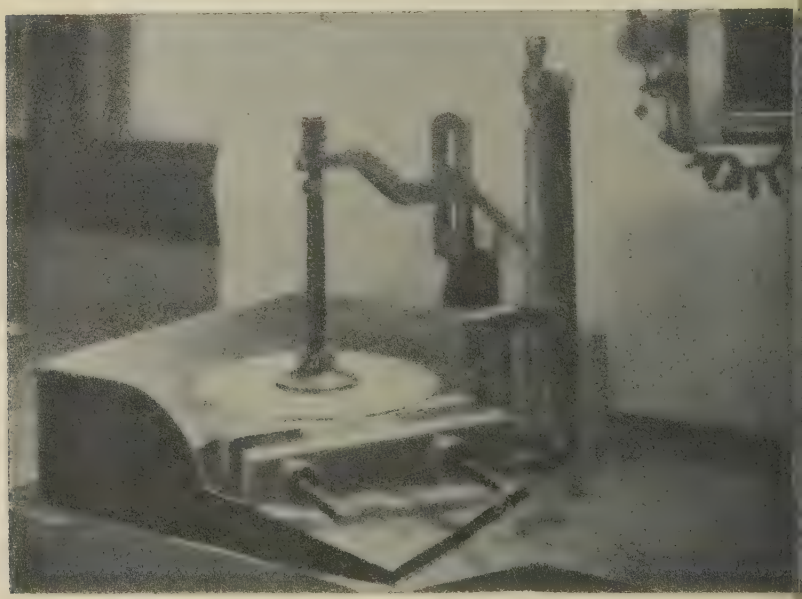


Fig. 1.—Slitting machine in the lapidary's shop in the Mineral Department of the British Museum (Natural History).

of large or awkwardly-shaped rocks being cut, the specimen-holder in such a case being placed above the slitting disc. If so desired, the spindle and the collars of the frame might be threaded so as to permit of successive sections being cut from a specimen at determined intervals. The standard supporting the spindle has underneath a pin which passes through the bench and is held by a nut. At the shoulder above the bench a metal plate is attached. A similar, but loose plate is underneath the bench. In addition to the pin mentioned three bolts connect the two plates so that they grip the bench firmly. The standard is of iron

except for the bearing centres and the pin underneath, which are of steel. By packing the upper plate the spindle may be adjusted towards the axis about which the slitting disc turns.

The slitting discs previously used, which were of the slightly conical kind common among lapidaries, were discarded, and plain ones, of sufficient thickness not to bend in the cut, substituted ; some difficulty was, however, experienced in obtaining truly plane ones. Soft iron discs which had been tinned held the diamond dust well, and gave

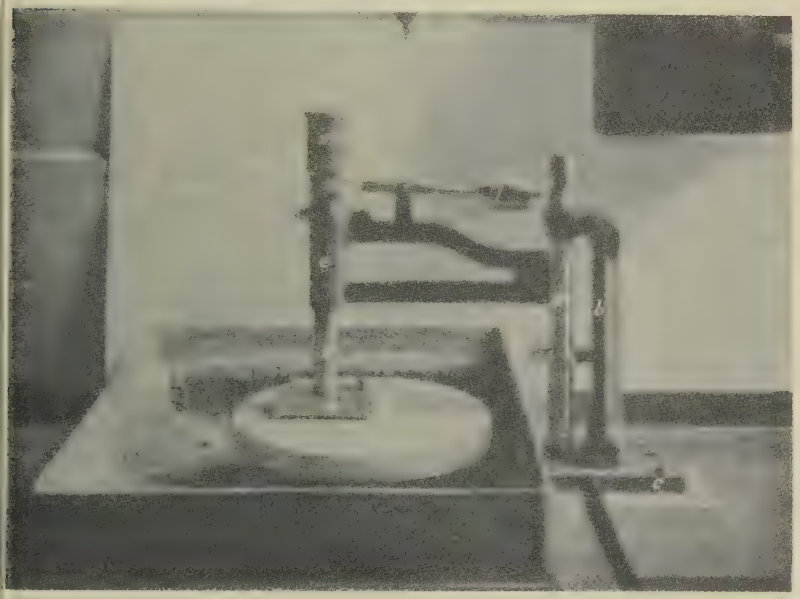


Fig. 2.—Grinding and polishing machine in the lapidary's shop in the Mineral Department of the British Museum (Natural History).

excellent results as long as they did not become distorted. Mild steel discs were tried ; they were very flat, but failed to retain the diamond dust. A sufficient number of resistances have been provided in the electric circuit to give a wide range of speeds in the motor to suit the varying kinds of rocks dealt with.

For use with the grinding-lap (fig. 2) a mechanical section-holder has been designed. The spindle (*a*) and the standard (*b*) supporting it are of the same type as those just described, but smaller in dimensions. The latter has no pin underneath it, but is held by four bolts passing through

its shoulder-plate (*c*). As before, the spindle may be adjusted towards the axis about which the lap rotates by packing the plate. The heads of the bolts underneath the bench are provided with washers to prevent their being pulled into the wood. A split-ring clamp (*d*) is fitted to the spindle to prevent the arm being carried round by the friction of the lap on the section. An arm (*e*), of gun-metal and about 9 inches (23 cm.) in length, is rigidly attached to the spindle. Its free end is cylindrical in shape, and is drilled with a smooth bore to take a steel tube (*f*), $\frac{7}{8}$ inch (22 mm.) in diameter. The upper part of the tube is threaded, and carries two nuts. The upper one (*g*) has a double flange wide enough to take the rollers fitted on pins on the inner sides of the forked end of the counterpoising lever. The second and lower nut (*h*) may be placed at any desired position to stop further grinding; as soon as it falls on to the top of the arm grinding automatically ceases. A precaution of this kind is desirable, because if the lap were left unattended for a while, the section might be ground away altogether. The clamp (*k*) is used to prevent any undesired rotation of the tube and the section; it is not necessary to tighten it so much as to interfere with its freedom to move up and down within its sleeve. The counterpoising weight (*l*) may be fixed by the screw to be seen in the figure at any point on the thin rod carrying it. The cylindrical box (*m*) at the top is partially filled with lead shot in order to secure sufficient pressure of the section of the grinding-lap. It has a short pin underneath which fits into a cylindrical hole in the tube. The section-holder (*n*) is constructed to take pieces of plate-glass, $3\frac{1}{2}$ by $1\frac{1}{2}$ inches and $\frac{1}{4}$ inch thick (89 by 38 by 6 mm.). It is provided with flanges on the longer, and lips on the shorter sides. At one end the piece carrying the lip may be pulled out far enough to allow the glass plate to be slipped under the other lip. The screw (*o*) holds the movable lip firmly in position. It will be noticed that the plate which the screw grips is slotted, but not cut through to the edge, so that the piece cannot be removed altogether without first removing the screw, and the risk of its accidental loss is minimized. At the back of the section-holder (above in the position of fig. 2) is a pin which fits into the tube, and is held by a screw-clamp (behind the tube and invisible in fig. 2); the pin is flattened where the screw impinges in order to give a better grip. The section-holder is of gun-metal, except for the flanges and lips, which are of brass.

The distance between the axes of the tube and the spindle is 9 inches (23 cm.), and between the axes of the spindles of the lap and the holder $7\frac{1}{4}$ inches (18·5 cm.), so that on turning the arm of the section-holder, the

section moves across the lap from one extremity of a diameter to another. It is not desirable to bring the section too near the centre of the lap, because the rate of grinding would vary appreciably over the section. The standard supporting the arm is of such a height that the hand may conveniently rest on the screw on the top of it while regulating by means of the counterpoise the pressure on the lap. By the feel of the counterpoise it is possible to judge if the work is progressing satisfactorily on the face of the section. By depressing the counterpoise the section is immediately brought clear.

The surface of the lap is now plane, and not convex as before. It has a conical pin underneath, which fits into a similar but hollow cone in the spindle, and is pressed tightly home by a wedge-shaped key pushed in transversely. The lap and its fittings have been very accurately constructed, but the surface of the lap is not quite exactly at right angles to the axis about which it rotates. The tube carrying the section-holder may, however, move sufficiently freely within its sleeve to maintain uniformity of grinding during the complete revolution of the lap.

The pieces of plate-glass are used to simplify the manipulation of the sections, because, being thick, they are far more easily dealt with than the ordinary slips. The latter are stuck to the plate-glass with bees-wax or other adhesive material, which melts at a lower temperature than Canada balsam; they are therefore fixed or removed without, if proper precautions are taken not to heat them too much, in any way interfering with the section or softening the Canada balsam.

The slitter cuts so truly flat that the surface of the piece of rock used requires no grinding and only a little rubbing down to finish it, and with ordinary care the section may be cut under $\frac{1}{20}$ inch (1 mm.) thick before grinding. Since high speeds of rotation of the grinding-lap are available a fine grade of carborundum or emery powder may be used, and little rubbing down is afterwards needed.

I was greatly assisted in designing the apparatus by many helpful suggestions made by my colleague, Mr. W. Campbell Smith, M.A., F.G.S., and I desire also to record my indebtedness to Mr. J. A. Plume for the zeal and interest which he displayed in carrying out my ideas.

The graphical determination of angles and indices in zones.[1]

(*With Plate XI.*)

By G. F. Herbert Smith, M.A., D.Sc., F.G.S.

Assistant in the Mineral Department of the British Museum.

[Read January 21, 1913.]

NINE years ago (in 1904) I described a diagram[2]—the moriogram, as I called it—which served for the graphical determination of angles and indices in the case of zones in which the principal poles included a right angle. It was, therefore, restricted in its application to zones in the cubic, tetragonal, orthorhombic, hexagonal, and rhombohedral systems, and to zones in the monoclinic system passing through the pole of symmetry. Although the moriogram may be used with sufficient accuracy for practical purposes in the case of many substances with triclinic symmetry, in which the angles between the principal poles differ little from right angles, there necessarily remain many instances in which it cannot be applied with any approximation to accuracy. Two methods have occurred to me of dealing with the perfectly general case, in which the angles between the principal poles may have any arbitrary value; the first of them is an immediate deduction from a property of the gnomonic projection, and the second is an extension of the moriogram referred to.

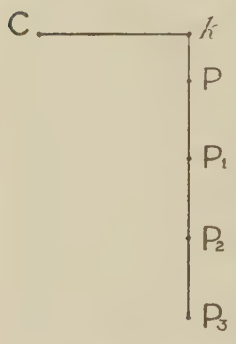


Fig. 1.

First Method.—In fig. 1 C is the central pole of the gnomonic projection, and $PP_1P_2P_3$ is a zone meeting the perpendicular zone through C in k. Then, if Ck, Pk, PP_1, PP_2, PP_3, represent respectively angles

[1] Communicated by permission of the Trustees of the British Museum.

[2] Mineralogical Magazine, 1904, vol. xiv, pp. 49–53.

ϕ, θ, A, B, C, the linear distances kP, kP_1, kP_2, kP_3, on the projection are as follows :—

$$kP = a \tan\theta \,.\sec\phi,$$
$$kP_1 = a \tan(\theta + A) \,.\sec\phi,$$
$$kP_2 = a \tan(\theta + B) \,.\sec\phi,$$
$$kP_3 = a \tan(\theta + C) \,.\sec\phi,$$

a being the radius of the sphere to which the projection corresponds.

The anharmonic ratio of four poles in a zone is equal to

$$\frac{\sin A}{\sin(C-A)} \cdot \frac{\sin(C-B)}{\sin B} = \frac{\sin\{(\theta+A)-\theta\}}{\sin\{(\theta+C)-(\theta+A)\}} \cdot \frac{\sin\{(\theta+C)-(\theta+B)\}}{\sin\{(\theta+B)-\theta\}}$$

$$= \frac{\tan(\theta+A)-\tan\theta}{\tan(\theta+C)-\tan(\theta+A)} \cdot \frac{\tan(\theta+C)-\tan(\theta+B)}{\tan(\theta+B)-\tan\theta}$$

$$= \frac{kP_1-kP}{kP_3-kP_1} \cdot \frac{kP_3-kP_2}{kP_2-kP} = \frac{PP_1 \,.\, P_2P_3}{P_1P_3 \,.\, PP_2}$$

If the pole P_3 be taken on the equatorial zone, which is at infinity on the projection, the anharmonic ratio reduces to

$$\frac{PP_1}{PP_2}.$$

Supposing P, P_1, P_2, P_3 have respectively the indices $10l$, $11l$, hkl, $01l$. We have

$$\frac{PP_1}{PP_2} = \frac{h}{k}.$$

Hence the distances from P of the various poles in the zone will between P and P_1 be sub-multiples, and beyond P_1 multiples of PP_1; thus if d be the distance between the poles $10l$ and $11l$ on the projection, we have the distances between $10l$ and other poles in the zone as under :—

$21l$	$\frac{1}{2}d$	$12l$	$2d$
$31l$	$\frac{1}{3}d$	$13l$	$3d$
$h1l$	$\frac{1}{h}d$	$1kl$	kd

The straight line in the projection representing the zone in question is therefore spaced out in simple multiples and sub-multiples of the unit. Now $PP_1 = a \sin A \sec\phi \sec\theta \sec(\theta+A)$, and varies with θ and A even if a and ϕ remain constant. We must, therefore, be able to vary the unit in the drawing. This may very simply be done by drawing a pencil of straight lines corresponding to the various poles, and by applying to them, as for instance in fig. 2, a double tangent scale at right angles to the

central straight line, in such a way that the latter lies on the angle included by the principal poles, for instance $ab(100:010)$, and the unit line 1 to the unit angle, for instance $am(100:110)$. The angles between $a(100)$ and the other poles, positive or negative, or the poles corresponding to the angles may be at once read off, if less than 30°, beyond which limit it is not convenient to draw a tangent scale. To obtain the angles beyond the limit, readings must be taken from the other principal pole, for instance $b(010)$, and should the unit angle be less than 30°, the angle corresponding to some other pole, for instance (210), within the limits of the scale must be used instead.

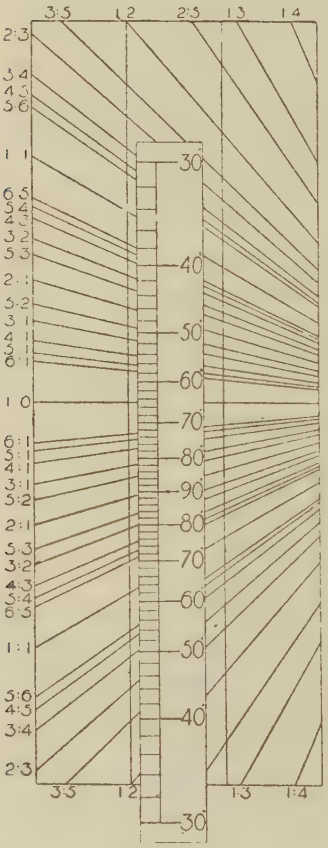


Fig. 2.

Second Method.—This is an extension of the moriogram, and the diagram (Plate XI) is a graphical expression of the equation

$$\frac{\cot\psi-\cot\psi_0}{\cot\psi_1-\cot\psi_0}=\frac{\cot\theta}{\cot\theta_1}\cdot\frac{n}{m},$$

where ψ_0 and ψ_1 are the constants for the zone, and stand, for instance, for the angles $ab(100:010)$ and $am(100:110)$, and ψ is the angle required corresponding to any ratio of indices m/n, for instance $mn\,0$.

The diagram is in two parts. That on the right hand is the simple moriogram, corresponding to zones in which the principal poles include a right angle. It is in a slightly different form, which is perhaps a little more convenient in the general case, both coordinates being tangent scales extending as far as 45°. The graphs, which have, as before, been drawn for all indices including numbers not larger than 10, are straight lines; they are inverted at the straight lines corresponding to 45°, and become rectangular hyperbolæ. The diagram is symmetrical about the diagonal running upwards from left to right.

The left-hand part of the diagram represents the equation

$$\cot\psi - \cot\psi_0 = \cot\theta.$$

Putting $x = \cot\psi$, $y = \cot\theta$, $c = \cot\psi_0$ we have

$$x - c = y,$$

which represents a series of parallel straight lines. In the diagram the origin is at the bottom on the right, the positive direction of y is vertically upwards, and of x horizontally from right to left; the coordinates are tangent scales. To avoid negative values of y, the lines are reflected in the axis of x, and run upwards from left to right. On reaching the line $x = 1$, corresponding to 45°, the lines are inverted, and we have a second series represented by

$$x'(c + y) = 1,$$

where $x' = 1/x$. The graphs are now rectangular hyperbolae. Carrying these as far as $y = 1$, and inverting with respect to y, i.e. putting $y = 1/y'$, we have

$$cx'y' = y' - x',$$

a series of rectangular hyperbolae passing through the origin.

To obviate hopeless confusion in the diagram, the graphs for values of ψ_0 between 90° and 180° have not been drawn, but they are precisely the same as those shown if the axes of x and y be interchanged.

In using the diagram, the inclined line corresponding to the angle, ψ_0, between the principal poles is followed to its intersection with the vertical line corresponding to the unit angle, ψ_1, and the resulting value of θ_1 is read off on the right-hand vertical scale. If ψ_1 is less than 45°, the second intersection, i.e. where the ordinate meets the curved graph, is taken, and, if it meets the inverted curve, the corresponding reading less than 45° on the vertical scale must be taken as θ_1.

If ψ_0 be greater than 90°, the procedure is similar, but we start from the vertical scale and read off the values of θ_1 on the horizontal scale. If ψ_1 be less than 45°, we take the first intersection of the ordinate with the graph, and if greater, the second; and, if it be greater than 90°, we must take the intersection with the inverted straight line running upwards from left to right.

From the left-hand diagram the values θ corresponding to other poles in the zone are read off, and the corresponding values ψ are obtained from the left-hand diagram by reversing the procedure given above.

Let us consider some examples on the diagram :—

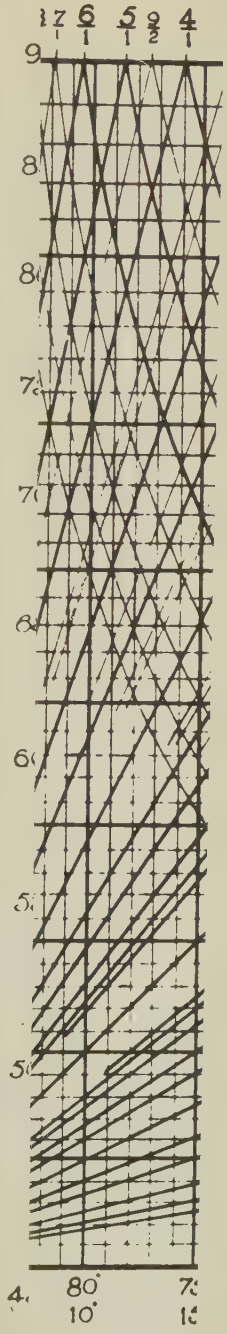
ψ_0	ψ_1	θ_1
80°	50°	$56\frac{1}{2}$°
,,	40	$44\frac{1}{2}$
,,	25	27
100	50	$44\frac{1}{2}$
,,	40	36
,,	25	$23\frac{1}{2}$
110	98	$77\frac{1}{2}$

As an example of the use of the moriogram we will take the zone *ac*(100 : 001) of epidote, the measurements given being from *c*(001).

Epidote.

Form.	θ	ψ	Calculated.[1]
105	$11\frac{1}{2}$°	$10\frac{1}{2}$°	10° 39′
102	$27\frac{1}{4}$	$22\frac{1}{2}$	22 31
101	$45\frac{3}{4}$	*	34 43
201	64	46	46 12
301	72	$51\frac{1}{2}$	51 26
100	90	*	64 37
$\bar{3}01$	72	$98\frac{1}{2}$	98 37
$\bar{2}01$	64	$89\frac{1}{2}$	89 26
$\bar{3}02$	57	$80\frac{1}{2}$	80 $16\frac{1}{2}$
$\bar{4}03$	54	76	75 51
$\bar{1}01$	$45\frac{3}{4}$	$63\frac{3}{4}$	63 42
$\bar{3}04$	38	$50\frac{3}{4}$	50 $44\frac{1}{2}$
$\bar{2}03$	$34\frac{3}{4}$	$45\frac{1}{2}$	45 37
$\bar{1}02$	$27\frac{1}{4}$	$34\frac{1}{4}$	34 21
$\bar{1}03$	19	$22\frac{1}{2}$	22 21
$\bar{1}04$	$14\frac{1}{2}$	$16\frac{1}{2}$	16 23

[1] Extracted from Dana's 'System of Mineralogy,' Sixth edition.


12 6 5 4
9
8
8
7
7
6
5
5
4
80°
10°

The mineral collection of Thomas Pennant (1726–1798).[1]

By W. Campbell Smith, M.A., F.G.S.
Assistant in the Mineral Department, British Museum.

[Read March 11, 1913.]

THOMAS PENNANT was born at Downing, Whitford, near Holywell, in 1726. A contemporary and correspondent of Linnaeus and Buffon, he is well known to zoologists as a pioneer of British zoology, and to him were addressed the letters of Gilbert White which form the greater part of 'The Natural History and Antiquities of Selborne'. He travelled very extensively in the British Isles and wrote many accounts of his tours, perhaps the best known being his account of London and his 'Tour in Wales'.

Up to the present, Pennant's sole claim to the attention of mineralogists has been his account of the mineral district of Flintshire, an account which appeared in 'A Tour in Wales' in 1778, and which was republished with some additions in 'The History of the parishes of Whiteford and Holywell' in 1796: it was largely quoted in the Geological Survey memoir dealing with that district.[2]

Though Pennant himself has told us very little of his study of minerals, his description of Flintshire shows that he had accurate information of the mines of that area and of the minerals which they produced. In 'The Literary Life of the late Thomas Pennant, Esq., By Himself', which he published in 1793, he tells us that in 1746 or 1747, while an undergraduate at Queen's College, Oxford, he made a tour from Oxford to Cornwall. In Cornwall he met William Borlase, Vicar of Ludgvan, and under his guidance commenced to collect minerals and fossils.

Though in 1793 Pennant felt that his literary career was at an end, he enjoyed five more years of a vigorous life. In 1796 he published 'The

[1] Communicated by permission of the Trustees of the British Museum.

[2] 'Geology of the neighbourhoods of Flint, Mold, and Ruthin,' Geol. Survey Memoir, 1890, p. 159 et seq.

History of the parishes of Whiteford and Holywell', which opens with an account of Downing, his birthplace and residence, and contains the following interesting statement: 'Downing may boast of a good and numerous collection of fossils and minerals, partly collected by myself, partly by my son in his extensive travels; many of the specimens are elegant, and most of them instructive' (p. 22). By the generous gift of the Earl of Denbigh this collection, after remaining almost untouched for more than a century, has become the property of the Trustees of the British Museum. The collection originally contained about 1,300 specimens; about 800 of these still remain, some 340 still bearing their original labels.

The son mentioned in the passage quoted above was David Pennant, eldest son of Thomas Pennant. He was elected a Fellow of the Royal Society in 1792. Sowerby[1] mentions him as the donor of specimens of calcite, calamine pseudomorphs, and blende. There are, with the collection, lists of Swiss and German minerals addressed to David Pennant, bearing various dates up to 1820, but there is no evidence of any work having been done at the collection after this date, either by David Pennant or by his son.[2]

Thomas Pennant was not only a keen collector of minerals and fossils, he was also a careful curator, and knew full well the value of an accurate catalogue. His earlier catalogues appear to have been destroyed, with the exception of a 'Catalogue of Flintshire Fossils'. This contains references to Hill's 'History of Fossils' (1748), and to Woodward's 'Natural History of the Fossils of England' (1729): it was never completed, but is especially valuable, as it contains an account of the collection of Flintshire calamine (Lapis Calaminaris), which does not find a place in his later catalogue.

In a letter to Edward Rawstone, in 1753, Pennant writes: 'I am very methodical in the disposition of my minerals. . . . I purchase most of the best writers on the subject, and from them shall form a new catalogue, with experiments made by myself and some few observations of my own.' This new catalogue has most happily been preserved: it extends to three quarto volumes of manuscript, the minerals occupying two volumes, entitled 'Native Fossils'.[3] There are some 1,250 entries, each entry

[1] J. Sowerby, 'British Mineralogy,' 1804, vol. i, p. 10; 1809, vol. iii, p. 1; 1811, vol. iv, p. 173.

[2] David Pennant, junr., was elected a Fellow of the Geological Society of London in 1818.

[3] The third volume deals with fossils. See R. B. Newton, Geol. Mag., 1913, dec. 5, vol. x, p. 192.

comprising a description of the mineral, the locality, the name of the collector and donor, and frequently some additional remarks.

The catalogues bear no date, but the fact that among the original entries is one referring to specimens collected at Llanberis in August of 1757, while the references to Borlase's 'Natural History of Cornwall', published in 1758, are later entries, enables the time of writing to be fixed as the winter of 1757. When Pennant wrote his catalogue, the most recent English work on 'fossils' was Hill's 'History of Fossils' (1748), and to this he makes frequent references. There are also references to Plot's 'Natural History of Oxfordshire' (1677), Lhuyd's 'Lithiophyllacium Brittanicum' (1699), and many other old works, but the style of the catalogue and the classification are based on Woodward's 'Natural History of the Fossils of England' (1729), from which frequently the definitions of classes are copied.

In the letter to Edward Rawstone, quoted above, Pennant wrote: 'Woodward's System is now generally esteemed the most plausible, and is what I favour, being very consonant to the structure of the Earth to such depths as I have ventured myself.'

The main outlines of Pennant's classification are given here, as it affords a very good idea of what he regarded as the important characters in minerals.

PENNANT'S CLASSIFICATION.

Class.	Minerals included.
II. Earths and Earthy Substances ...	Clays, lithomarge, pyrolusite (wad), steatite, serpentine, talc-chlorite-schist.
III. Talcs and Talky Bodies	Anthracite, barytes (Lapis bononiensis), graphite, mica, molybdenite, talc.
III. Selenitae	Gypsum (crystals).
IV. Alabasters (Gypsa or Plaister stones)	Alabaster, pyrophyllite.
V. Fibrous Fossils :	
i. Of the same genus with Class IV, and like them burning to a Plaister	Gypsum (satin-spar).
ii. Not calcining, or suffering scarce any alteration in the fire	Asbestos, chrysotile.
VI. Crystals :	
i. Composed of the common crystalline matter	Fluor, quartz.
i a. Schirl or Cockle	Hornblende.
ii. Of the finest kind, or Gems ...	(No entries.)
VII. Spars :	
i. Crystalliform or cubic spars ...	Calcite.

Class.	Minerals included.
ii. Spars breaking into rhomboid or parallelepiped masses. Among these I place the *fluores lamellati* on account of their breaking into parts of that shape	Barytes, calcite.
iii. Terrene incrusting spars, alabastrine spars, tuberous and efflorescent spars. *Fluores ericaeformes*	Calcite.
iv. Stalactitae	Calcite.
v. Stalagmitae	Oolites and spherulitic structures.
VIII. Fossils which are solid and formed into strata :	
i. Stone of a coarse texture, or quarry stone	
a. Freestone, or such that break with equal indifference in any direction.	
b. Slates, or stones which split only horizontally.	
ii. Stone of a fine texture whose basis is spar. Marble :	
a. Forming strata.	
b. Found in nodules.	
iii. Stone of a fine texture whose basis is crystal with some mixture of talc. Granite :	
a. Composing strata.	
b. Found in nodules.	
iv. Stone of the finest and hardest texture whose basis is crystal, coloured and spotted with different kinds of earth. Porphyry.	
IX. Ludi Helmontii, or septaria.	
X. Crustated ferruginous bodies (including Bezoar minerals).	
XI. Fossils found in small roundish masses or nodules, whose basis is crystal, sometimes pure but generally more or less debased with earth :	
i. The semipellucid gems	Chalcedony, sard, garnet.
ii. Opake gems	Jasper, &c.
iii. All the different kinds of pebles and flints	Jasper, menilite, wax-opal, serpentine
iv. Sands.	
v. Gritts.	
XII. Salts	Halite.
XIII. Bituminous Fossils :	
i. Such as are solid : coals, jet, amber, and the like	Amber, coal, copalite, jet.
ii. Liquid, as bitumen, naptha, petroleum	Bitumen.
XIV. Sulphurs	Sulphur.

Class.	Minerals included.
XV. Slags and other substances vomited out of volcanoes.	
XVI. Marcasites and pyritae :	
i. Marcasites : those that are found in the veins or perpendicular fissures	Chalcopyrite, iron-pyrites, mispickel (mundic), blende (mock-ore).
ii. Pyritae : those which are found independent and lodged in strata	Marcasite (concretions).
XVII. Semi-metals	Cinnabar, ores of antimony and cobalt.
XVIII. Gold.	
XIX. Silver	Molybdenite, silver.
XX. Tin	Cassiterite.
XXI. Lead	Cerussite, galena, pyromorphite.
XXII. Copper	Azurite, copper, cuprite, malachite.
XXIII. Iron	Haematite, limonite.

The classification was evidently never quite satisfactory. 'Lapis Calaminaris' (calamine, $ZnCO_3$), which figured prominently in the 'Catalogue of Flintshire Fossils', found no place in the new catalogue; and it was frequently difficult to assign a mineral to one class when it showed the properties of several. Barytes presented particular difficulties in this respect, and it figures under both 'talcs' and 'spars' in its different forms.

Although Pennant distinguishes between 'cubic spars' and 'spars breaking into rhomboid or parallelepiped masses', he appears to have had no idea of the importance of interfacial angles. Thus, when describing the calcite of Pen-y-bryn, he says: 'They break constantly, even to the most minute particles, into parallelepipeds. . . . They are exactly of the same structure and break into pieces of the same form as the common potter's lead-ore [i.e. galena], and very probably may determine that species of ore to that figure, and what is a support to this conjecture is its being commonly found accompanying lead-ore.' It must be remembered that this was written fifteen years before Romé de l'Isle published his famous 'Essai de Cristallographie' (1772), and nearly thirty years before the writings of Haüy.

Pennant appears to have procured later books on minerals, whenever such were published in English or Latin. Thus one finds later entries referring to Cronstedt's 'System of Mineralogy', translated by Engestrom, with notes by da Costa (1770), and to the later edition by Magellan (1788). In 1772 appeared Wallerius's 'Systema Mineralogicum', and from this Pennant copied the classifications of ores and suggested

modifications. All these books, however, came when he was fully occupied with his zoological work.

Pennant's catalogues contain references to many friends who added largely to his collection. The contributions of three of these call for special attention.

Rev. William Borlase, who has already been mentioned as arousing Pennant's interest in minerals, sent seventy-eight specimens, of which twenty-six are still identifiable. He was the author of a paper entitled 'Spar and Sparry Productions called Cornish Diamonds',[1] and of 'The Natural History of Cornwall'. In the latter work he enumerates eight kinds of 'steatite',[2] of which four are still represented among Pennant's minerals. Against the entry in his catalogue Pennant has written the number used by Borlase in his description. Numbers I and IV are true steatite from the Soap Rock, near The Lizard, the location of which is given in Pennant's catalogue. Number VI is, however, lithomarge, and number VIII is serpentine.

Another interesting specimen is one of 'flake ore'[3] (botryoidal chalcopyrite). Mamillated malachite was known as 'enamelled copper ore'; and a mass of fine-grained native copper and cuprite in white quartz is called by Borlase 'red copper'.

Erich Ludvigsen Pontoppidan (1698–1764), Bishop of Bergen, was the author of 'The Natural History of Norway' (1755), (translated from the Danish, 1753). Pennant's own copy of this book is in the possession of the Countess of Denbigh, to whom I am indebted for the following information. At the beginning of the book Pennant has written: 'The places marked with a † denote what the author of this history has presented me, A.D. 1756.' The minerals thus marked are: Amianthus, or asbestos rock, p. 89; Amianthus, section VI, p. 168; Copper from Röraas, p. 192; and Iron, section XII, p. 199.

Pennant's catalogues show that Pontoppidan presented him with fifteen specimens of minerals, several of which are described in 'The Natural History of Norway'. Eleven of these have been identified. The most interesting are: the 'Veegsteen' or 'Talkstein',[4] a talc-chlorite-schist; asbestos[5] from Birkedal fen, in the parish of Waldens, which had been regarded as petrified wood until Pontop-

[1] W. Borlase, Philosophical Transactions, 1749, vol. xlvi, p. 250.
[2] W. Borlase, 'The Natural History of Cornwall,' Oxford, 1758, p. 67.
[3] W. Borlase, ibid., p. 197.
[4] E. L. Pontoppidan, 'The Natural History of Norway,' London, 1755, p. 166.
[5] E. L. Pontoppidan, ibid., p. 89 and p. 168.

pidan pointed out the error; 'Lapis suillus'[1] or 'Swine's stone' (fetid barytes).

Emanuel Mendes da Costa (1717–1791) wrote original notes and additions to Engestrom's translation of Cronstedt's Mineralogy (1770) and 'A Natural History of Fossils' (1757).[2] He was in correspondence with Pennant in 1752, and it is an extraordinary fact that none of the correspondence is preserved with da Costa's other letters at the British Museum. Contemporary letters show that in 1756 the two collectors had some disagreement, but in 1757 we find da Costa mentioning Pennant first among 'the gentlemen who have generously communicated their observations or favoured me with specimens from their collections'.[3] He contributed forty-three specimens to Pennant's collection: of these only five are now identifiable, three of which are described by da Costa:[4] viz. *Steatites* from Fichtelberg, Franconia; *Steatites indurata* from Wunsiedel; and wad (*Ochra friabilis nigro-fusca*, or 'black wadd') from Portaway lead-mine, near Winster, Derbyshire. No other specimens in the collection can be identified with da Costa's descriptions.

Turning now to the minerals collected by Pennant, one finds only a few, apart from the Flintshire minerals, which possess more than historic interest. There are, however, some which deserve mention.

Among the foreign minerals the only specimen of much interest is one of green serpentine. This is classed with the 'Jaspers', and is described as 'a Nephritic Stone from the Harz Forest'. Pennant probably had this specimen from da Costa, who gave him many German minerals, and who refers to the 'Nephritic Stone' or 'Jasper' of the Harz forest.[5] The fact that this is not true nephrite throws some light on these old records.

A large series of iron-ores from the Forest of Dean are of interest, as Pennant has recorded the miners' names then in use for the different ores. These include varieties of 'Brush Ore', 'Mayburn', 'Pipey Ore', 'Grey Ore', and 'Smith Ore'.

A fine piece of mendipite from the Mendip Hills was entered in the

[1] In his description of this specimen Pennant writes: 'Sent me by Bishop Pontoppidan with the title of Lapis suillus or Swine stone, perhaps from its offensive smell, though he, in his history, p. 168, derives its name from another cause, viz., its efficacy in curing the orasiuk, a disease among the swine in Norway, where this spar is found in great quantities.'

[2] The proposals for this book were issued in 1752, but only one part was ever published.

[3] E. M. da Costa, 'A Natural History of Fossils,' London, 1757, p. vi.

[4] E. M. da Costa, ibid., pp. 41, 102.

[5] E. M. da Costa, ibid., p. 40.

catalogue after 1757. The only other specimen of this mineral is a small piece given to Pennant by John Hughes as coming from Galway, Ireland: it is, however, almost certainly from the Mendips.

Several specimens of malachite, labelled Staffordshire, are probably from Ecton. They include one pseudomorph after chalcopyrite, the chalcopyrite being altered to limonite.

A specimen of copalite, similar to 'Highgate resin', is described as amber, and comes from 'the great clay pit at Richmond, Surrey'.

'Pitch' from Pitchford, Shropshire, is interesting, as the specimen was described by Pennant.[1]

Pennant visited Ireland in 1754, but never published any account of his journey. The catalogue contains an entry of specimens collected at Killarney on August 22, 1754. He visited Muckross, Co. Kerry, and it is very interesting to note that Pennant's visit to this copper mine was made just at the close of its period of great prosperity (1749–54), during which large quantities of cobaltite were found.[2] Pennant's minerals from Muckross, however, consist only of chalcopyrite, fahlerz, and a curious mass of limestone impregnated with native copper. A fair collection of cerussite from the Silvermines district, Co. Tipperary, was also made on this Irish tour.

Perhaps the most interesting specimen in the collection is one described as 'Dark greyish copper ore, mixed with a pale red, from a mine on Llanymynech Hill, Shropshire'. The pale red mineral has been identified by Mr. Arthur Russell as rhodochrosite. The occurrence of these crystals is not mentioned by Pennant in his account of Llanymynech Hill.[3] The other specimens from this locality are stalactites of calcite and some very fair cubo-octahedra of galena.

The treatment of the Flintshire minerals has been left to the last; and as they constitute the basis of Pennant's description of the mineral district of Flintshire and represent the produce of many mines well known to Pennant, but long since closed down, they will be treated in some detail.

Pennant described a 'green lead ore'[4] as being found in small amount some years previous to 1778 in the Silver Rake on Halkin Mountain. The catalogues contain records of seven specimens of this green lead ore, all from the Silver Rake. They are described as being 'of a dark green

[1] T. Pennant, 'Tour in Wales,' London, 1810, vol. iii, p. 264.
[2] Trans. Geol. Soc. London, 1821, ser. 1, vol. v, p. 595.
[3] T. Pennant, 'Tour in Wales,' London, 1810, vol. iii, p. 218.
[4] T. Pennant, 'Tour in Wales,' 1778, p. 418.

colour, of a stony appearance and breaking with a smooth surface like that of flint', sometimes covered with 'minute sparkling green crystallizations' or with 'elegant tubera, some of which are smooth, others crystallized'. The green ore is associated with 'brown stony ore or cauke', or with 'pale whitish green crystallized ore, which appear on some parts like efflorescences, on others like thin laminae, and are semipellucid'. The best green ore is entered as yielding '1200¾ lb. of lead to the ton, but scarce any silver'. It is much to be regretted that only one of these valuable specimens has survived with its label still attached. It consists of galena, coated with well-crystallized cerussite (the 'pale whitish green crystallized ore') and some pale-green botryoidal pyromorphite. It has been suggested[1] that the green lead ore may have been anglesite. However, the descriptions in the catalogue and the evidence of the sole-remaining specimen prove that its identification with pyromorphite is correct. Pyromorphite was again recorded from Flintshire by Traill[2] in 1821, a large quantity being found in a mine called Gelly-Fowler Fields, on Halkin Mountain.

The 'brown lead ore', 'caulk' (or 'cauke') of Pennant[3] is cerussite, as are also 'the pellucid crystallizations of ore' mentioned in his catalogue.

Calamine ($ZnCO_3$) is only briefly described by Pennant,[4] but the 'Catalogue of Flintshire Fossils' contains elaborate details of forty-five specimens. Nineteen of these have been identified with certainty, and besides these there are forty-one specimens which either have lost their labels or were never entered in the catalogue. They include fine, canary-yellow, botryoidal specimens from Talargoch, 'from a Drift the side of the Hill with a stream running through it'. Other specimens worthy of mention are eight from Moel-y-crio, Halkin Mountain. Seven of these are pseudomorphs after calcite; they include a large hollow crystal showing a scalenohedron twinned on (111), others are prisms $\{\bar{1}10\}$ with $\{2\bar{1}\bar{1}\}$, others again show $\{110\}$ and $\{2\bar{1}\bar{1}\}$. The eighth specimen is an epimorph of green calamine on cubes of purple fluor.

Moel-y-crio also yielded cleavage fragments of fine yellow fluor, but this was not described by Pennant.

The only spar described is 'refracting spar, *Spatum Islandicum*, of

[1] 'Geology of the neighbourhoods of Flint, Mold, and Ruthin,' Geol. Survey Memoir, 1890, p. 173.

[2] T. S. Traill, Edinburgh Philosophical Journal, 1821, vol. iv, p. 246.

[3] T. Pennant, 'Tour in Wales,' 1778, p. 418.

[4] T. Pennant, ibid., p. 420.

great purity and transparency, and often elegantly infected with marcasite finely disposed', from Pen-y-bryn mine, Holywell.[1] The catalogues contain nine entries of the spars from Pen-y-bryn mine. These are described as sometimes colourless, sometimes tinged with yellow; many of them enclosed layers of small 'green and gold marcasites', which in one case marked out another rhombohedron within the mass. Pennant adds a note to his entries as follows: 'These spars burn to a white colour and slake with water to a lime, but will not run in the fire, though I have tried them with the black flux and strongest heat my furnace is capable of.' Again it is most regrettable that only one of these spars remains: this is a cleavage rhombohedron of a pale yellow colour and is fairly clear.

Mr. Rudler has suggested[2] that the included 'marcasites', mentioned as occurring in the Pen-y-bryn calcite, may have been chalcopyrite, a suggestion which is confirmed by Pennant's description of them as 'green and gold' or 'of a brassy bright green colour'.

A petroleum, or rock-oil, is described by Pennant,[3] and a specimen in the collection is recorded as 'a kind found frequently in the limestone rocks in the lead mines at Brocknalt, near Holywell, and flows out of them when they are split or blasted. . . . It is of an oyly feel, a deep brown colour, and though liquid when first found hardens to a pretty thick consistency when long kept.'

Another specimen which may be mentioned is a small iron wedge or chisel, 5¼ inches long, encrusted with galena and rust, from Talargoch mine. This is described by Pennant[4] as evidence of the antiquity of the workings.

Pennant was very careful to record the exact localities of his Flintshire minerals. The catalogues contain entries of some 110 specimens representing twenty-six localities. The number of these specimens which can still be identified is only about thirty, but, as the descriptions of the minerals are clear, the species of the missing specimens can usually be made out by comparison with descriptions of others which have survived. The catalogues themselves therefore present a record of the mines which were working up to 1757 and of the minerals then obtained. The

[1] T. Pennant, 'History of the parishes of Whiteford and Holywell,' London, 1796, p. 254.

[2] F. W. Rudler, 'Handbook to the Minerals of the British Isles in the Museum of Practical Geology,' 1905, p. 124.

[3] T. Pennant, 'Tour in Wales,' 1778, p. 421.

[4] T. Pennant, 'History of the parishes of Whiteford and Holywell,' 1796, p. 122.

following tabulated list has been prepared, giving Pennant's localities, the identification of these localities on the one-inch Ordnance map, and the minerals occurring at each. It is hoped that this list may be of use to those interested in Flintshire localities.

Pennant's Localities.	Localities on 1-inch Ordnance Maps.	Minerals recorded by Pennant.
Daller Goch, near Disert.	Talargoch, Dyserth.	Calamine ($ZnCO_3$).
A mine above Disert.	On Craig-fawr, Dyserth.	Malachite.
Gronant mine, near Trelacre.	Talacre mine, near Gronant, Llanasa parish.	Galena (gravel-ore), Galena with cerussite,
Gronant, near Llanasa.		Calamine (black).
Treloggan (Treloggin or Trelogin).	Trelogan, Llanasa parish.	Marcasite (?), Galena and blende on massive calcite, Calamine, pseudomorph after calcite.
Pen-y-gelli, Whiteford parish.	Coed Pen-y-gelli, Whitford parish.	'Dull dark grey ore, yielding 500 lb. of lead to the ton.'
Bryn-y-caseg, Whiteford.	Bryn-y-gaseg, Whitford parish.	Chalcopyrite (?), Calcite, cleavage rhombohedron (?).
Crecas.	Crecas, Whitford parish.	Iron-pyrites (?), Galena with cerussite.
Pen-y-Ball.	Pen-y-Ball, Holywell parish.	'Fine plated spar, yellow' = Calcite (?).
Maes-Whiteford.	Maes Whitford, Holywell parish.	Calcite, scalenohedra (?).
Brocknallt.	Brocnallt, Holywell parish.	Petroleum, Galena.
Pen-y-Bryn.	Pen-y-bryn, Holywell parish.	Calcite, Chalcopyrite, Calamine.
Quoitia Mawr.	Coetia-mawr, Holywell parish.	Calamine.
Butler's Fields.	? Coetia Butler, Holywell.	Calamine.
Pant-y-Godidw.	?	,,
Driniog.	?	,,
Bryn-driniog.	?	,,
Llin eer.	?	,,
Ty Maen.	?	Calcite (?).
Claudh mine, Holywell.	? Clawdd-fford (or Cornelpylle), Brynford parish, near Holywell.	Galena, Cerussite, Calamine.
'A mine near Caerws.'	Near Caerwys.	Calcite.
Silver Rake, Halkin Mountain.	Silver Rake, on Halkin Mountain, Brynford parish.	Pyromorphite, Cerussite, Galena.
Pentre Halkin.	Pentre Halkin, Halkin parish.	Calamine.
Pant.	?Pant lode, Halkin parish.	Fluor (pinkish-violet), Galena (plated lead-ore), ,, (gravel-ore), Calamine.

Pennant's Localities.	Localities on 1-inch Ordnance Maps.	Minerals recorded by Pennant.
Moel-y-Cria, Halkin Mountain.	Moel-y-crio, Halkin parish.	Fluor (clear, yellow cleavage masses),
		Fluor (small, pale-purple cubes),
Moel-y-Cria, near Rossesmer.	,, ,,	Calamine, pseudomorphs after calcite and fluor.
'A mine 70 yards deep.'	Probably Moel-y-crio, Halkin parish.	Fluor, dark-purple cubes, with calamine.
Coccoed, near Kilken.	Near Cilcain.	Calamine.
Newmarket parish.	Newmarket parish.	Limonite (Linden's 'gold ore').

By his careful cataloguing Pennant has left us a valuable record of the mineralogy of his time, and in particular of the mines and minerals of Flintshire. The collection is one of considerable historical value, especially as it represents the work of ten years of Pennant's life of which he has told us little in his writings. All that is known of Pennant's work from 1747, when he met Borlase in Cornwall, to 1761, when he published 'The British Zoology', is that he wrote two papers in the Philosophical Transactions, one dealing with an earthquake in Flintshire,[1] the other describing some corals.[2] It is extremely interesting to find that these few years were as fully occupied as the rest of the strenuous life of this early naturalist, and it is hoped that these few notes will serve to show that they were not spent in vain.

[1] T. Pennant, Philosophical Transactions, 1750, vol. xlvi, p. 687.
[2] T. Pennant, ibid., 1756, vol. xlix, part ii, p. 513.

Ilmenite from the dolomite at Binn, Switzerland.

By Professor W. J. Lewis, M.A., F.R.S.

[Read November 12, 1912.]

As is well known, the dolomite of the Lengenbach quarry is rich in pyrites and has some rutile; the crystals of the latter being very small and somewhat infrequent. It seems therefore strange that the presence of hematite or ilmenite has not hitherto been recorded. This last summer I obtained a specimen which showed a minute black crystal with numerous faces, which I began examining under the impression that it was a sulpharsenite. After numerous zones were measured, it became fairly clear that a triad axis was present; and a comparison of the angles with those given in Miller's edition of Phillips's 'Mineralogy' (1852) led me to the conclusion that the crystal was one of hematite or ilmenite. Careful examination has confirmed this conclusion; and as, unfortunately, the crystal was broken in trying to clear away matrix for further readings, I was able to get the streak, which was dark brown to black and not red. It follows therefore that the substance is to be regarded as ilmenite.

The numerous zones measured have not proved redundant; for I became aware of a remarkable relation: (a) between the zone $[ae] = [100]$ of rutile and two zones of ilmenite, to which the symbols $[1\bar{1}1]$ and $[10\bar{1}]$ can be given; and (b) between the zones $[100]$ and $[1\bar{2}1]$ of ilmenite with one another and with the zone $[1\bar{1}0]$ of rutile. So that measurement of two zones may still leave the nature of the substance uncertain if they happen to belong to these two sets. The relations are shown in the following tables, in which Miller's letters, symbols, and angles are given:—

Ilmenite (Miller).				Observed.	Rutile (Miller).	
$ae = 01\bar{1} : 101$	57° 41′	$or = 111 : 100$	57° 33′	57° 30′	$ae = 100 : 101$	57° 13′
$au = 101 : 211$	32 19	$rb = 100 : 2\bar{1}\bar{1}$	32 30	32 24	$ec = 101 : 001$	32 47
$ar = 01\bar{1} : 001$	43 5	$o\pi = 111 : 012$	42 11	42 58	$cs = 001 : 111$	42 20
$ae = 001 : 011$	46 55	$\pi a = 012 : \bar{1}01$	47 49	47 2	$sm = 111 : 110$	47 40

This table makes it clear that a crystal may be wrongly interpreted unless more than these two zones are measured. In ilmenite the angles $57\frac{1}{2}°$ and 42°–43° are measured from the same face; in one case the common plane is the base, in the other it is a face of the hexagonal prism $\{10\bar{1}\}$. Rutile is at once excluded, for the angle $57\frac{1}{4}°$ is measured from the prism face (100), whilst that of 42° 20′ is measured from the base (001). But when rutile has been thus excluded, we have the possibility of error in taking the face from which the angles in ilmenite are $57\frac{1}{2}°$ and 42°–43° either as base or prism face. A third zone, fixing the angle between these two zones, becomes necessary. If the angles are measured from the base, the zones are inclined to one another at angles of 30° or 90°; if they are measured from a prism face $(10\bar{1})$, the zones are inclined to one another at an angle of 38° 7′. In the ilmenite from Lengenbach this angle was found to be 38° 18′.

In habit the crystal is much like one of the prismatic (orthorhombic) system; and the faces of a form have very unequal size. To show the accordance with ilmenite I give the following table of angles:—

Ilmenite.

Forms.	Computed.	Observed means.	No. of distinct observations.
$ae_{\prime} = 10\bar{1} : 110$	57° 36′	57° 33′	1
$e_{\prime}u = 110 : 121$	*	32 24	4
$ul = 121 : 275$	15 11	14 48	1
$le = 275 : 011$	17 13	17 35	1
$ar = 10\bar{1} : 100$	43 1	42 58	1
$re' = 100 : 101$	46 59	47 2	1
$e'o = 101 : 111$	38 13	38 12	1
$ou = 111 : 121$	21 29	21 31	1
$ur' = 121 : 010$	36 6	36 4	1
$or' = 111 : 010$	57 35	57 28	1
$e'u = 101 : 121$	59 42	59 44	2
$au = 10\bar{1} : 211$	71 30½	71 33	1

Calcite crystals from a water-tank.

By Russell F. Gwinnell,[1] B.Sc., A.R.C.Sc., F.G.S.

Demonstrator in Geology, Imperial College of Science and Technology.

[Communicated by Dr. C. G. Cullis, and read November 12, 1912.]

A CRYSTALLINE deposit of sufficient interest to warrant description was brought to the author's notice by Mr. Henry Preston, F.G.S., who has recently described its mode of occurrence.[2] The material consists of a white, glistening, crystalline powder, or a sand-like aggregate of minute crystals. It was deposited in a water-tank into which water was led through an old leaden pipe, over a mile in length, from a spring issing from the basal ferruginous beds of the Marlstone (Middle Lias) in Belton Park, north of Grantham, Lincolnshire. The sand was deposited in the tank as a conical heap, spreading over a base of perhaps four square yards and reaching a height of seven or eight inches at its summit. It formed during the dry summer months of 1911, when the inflow of water, though never ceasing, was never more than a trickle. Since that season the flow has been greater and no further deposit of crystals has formed, but only mud.

No crystals were deposited in the catchpit at the intake end of the pipe, and the hardness of the water was slightly greater there than at the outfall end. It is obvious, therefore, that the crystals were formed during the passage of the water through the long pipe, when the free surface of water was large as compared with its volume.

An analysis of the deposit, kindly made by Miss M. B. Chapman, B.Sc., D.I.C., gave the following result:—

$CaCO_3$	...	...	95·65
Al_2O_3	...	...	0·93
Fe_2O_3	...	....	0·21
SiO_2	...	...	3·14
Insoluble residue		...	0·06
			99·99

[1] The author of this note died suddenly on March 15, 1913, at the early age of 33 years.

[2] H. Preston, 'Calcite sand at Belton, Grantham,' Trans. Lincolnshire Naturalists' Union, 1912 (for 1911), vol. ii, pp. 307, 308.

The material dissolved with brisk effervescence in dilute hydrochloric acid, leaving a slight residue, the mineral characters of which could not be identified under the microscope.

Microscopic examination of the deposit itself shows it to consist entirely of transparent, colourless crystals, mostly of undistorted rhombohedral form. While a few crystals reach 0·2 mm. in greatest length, the majority lie between 0·05 and 0·15 mm. Isolated crystals are common, and aggregates of two, three, or more individuals are also found. These aggregates do not appear in any cases to be twins, but they are frequently due to parallel growth. The crystals have the

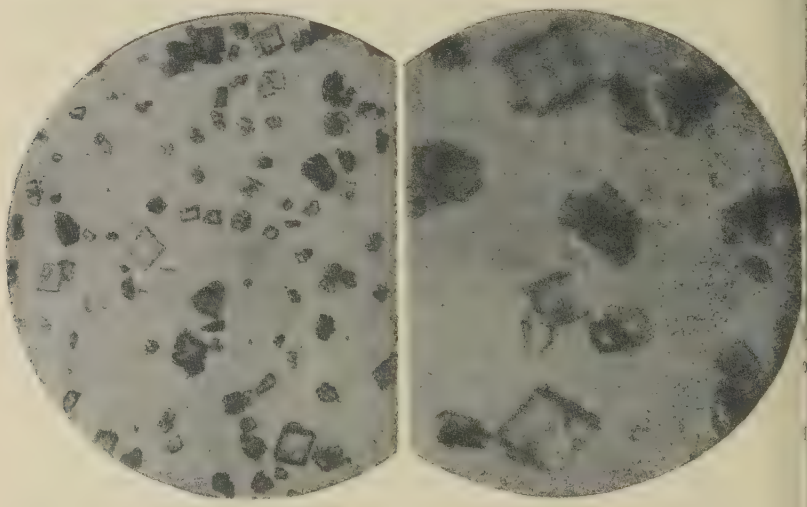


Fig. 1 (× 25). Fig. 2 (× 50).
Photomicrographs of Calcite crystals from a water-tank.

appearance of the primary rhombohedron r $(10\bar{1}1)$ of calcite; but it must be remembered that the acute rhombohedron f $(02\bar{2}1)$ may present much the same general appearance, since the interfacial angles of these two rhombohedra are approximately supplementary. The form of the undistorted crystals was observed, however, to be symmetrical with respect to a line joining the obtuse angles rather than to a line joining the acute angles of the faces; thus proving that the rhombohedron is r and not f. This conclusion was afterwards confirmed when cleavage-cracks were noticed in a few of the crystals.

The unit or cleavage rhombohedron r $(10\bar{1}1)$ is distinctly uncommon as a simple crystal-form in calcite, although usual in dolomite, &c. That

the mineral is calcite, nevertheless, and not dolomite, was proved, apart from chemical analysis, by optical means and by specific gravity. The latter was determined by the diffusion column to be 2·71. To determine the refractive indices the crystals were immersed in mono-bromonaphthalene and examined in plane-polarized light. Using monochromatic yellow light, it was found by Schroeder van der Kolk's method that for the ordinary ray the refractive index was approximately the same as that of the liquid ($n = 1{\cdot}66$), while for the extraordinary ray it was much lower. Examined in white light, the colour-fringes given with the ordinary ray confirmed the closeness of its refraction to that of the immersing liquid. This agrees well with calcite and precludes dolomite, which has higher refraction.

The deposition of these rhombohedral carbonate crystals under artificial conditions is of geological interest as bearing on the probable mode of origin of somewhat similar occurrences under natural conditions; and such have been recorded from a number of geological horizons. It tends to strengthen the view put forward by Dr. C. G. Cullis,[1] that the presence of similar crystals of dolomite in sediments of argillaceous character is indicative of direct precipitation from solution concurrently with sedimentation of the associated clayey matter. The alternative views that have been advanced to account for their presence in some of these deposits—as by mechanical transport or by metasomasis—obviously cannot explain the present occurrence.

[1] C. G. Cullis, 'On a peculiarity in the mineralogical constitution of the Keuper Marl,' Rep. British Assoc. (Leicester), 1907, p. 507.

Note on the determination of the optic axial angle of a crystal in thin-section by the Mallard-Becke method.

By Harvey Collingridge, B.Sc., F.G.S., A.M.I.C.E.

[Read January 21, 1913.]

MALLARD'S original method[1] was based on the measurement of the linear distance, as determined by an eyepiece-micrometer, between the optic axes in a section of the crystal at right angles to the acute bisectrix viewed in convergent light.

Professor F. Becke improved on this method by utilizing sections which were not at right angles to the acute bisectrix, but in which both optic axes were visible in the field. He projected both axes by means of an Abbe camera lucida on to a revolving drawing-table, and by means of the Mallard equation plotted the axes on a stereographic projection and thus obtained the optic axial angle, the angles of course being corrected for refraction to the true angles in the crystal section. Professor Becke[2] subsequently, by utilizing the Biot-Fresnel law, formulated a graphic method of obtaining the optic axial angle from a section in which only one axis was visible.

As a controversy has arisen between Professor Becke and Dr. F. E. Wright as to the correct method of obtaining the position of the second axis, and as the method the author proposes seems to avoid the debatable point, a brief résumé is given below.

[1] E. Mallard, Bull. Soc. minéralog. de France, 1882, vol. v, pp. 77–87.

[2] F. Becke, Min. Petr. Mitt. (Tschermak), 1905, vol. xxiv, pp. 1–34. See also J. W. Evans, Mineralogical Magazine, 1907, vol. xiv, pp. 230–234 and 276–281.

Professor Becke's method is as follows (fig. 1):—

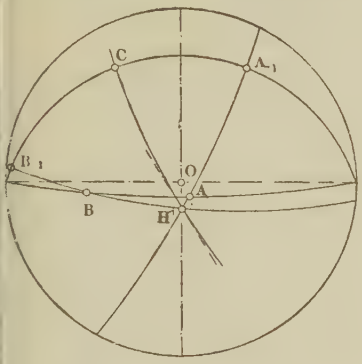


Fig. 1. Beck's method.

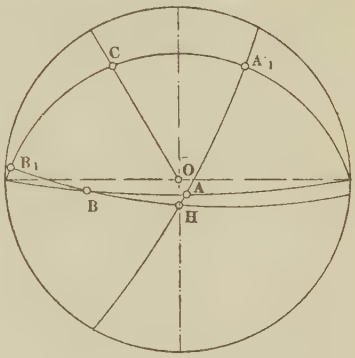


Fig. 2. Wright's method.

The visible isogyre is first drawn when it forms a straight line in an east and west direction, thus determining the optic axial plane. The section is then turned through any convenient angle, say 30° to 45°, and the drawing-table is revolved the same amount in the same direction. The new position of the isogyre is then drawn. The intersection of the two traces of the isogyre gives the position of the visible optic axis A. Any convenient point H on the second position of the isogyre is taken and with A is transferred, duly corrected for refraction, to a stereographic projection. A great circle through A on an east and west diameter is drawn, thus marking the optic axial plane, and on which consequently the second optic axis must lie. A great circle HAA_1 is drawn through H and A. Another great circle A_1CB_1, of which H is the pole, is drawn cutting HAA_1 in A_1. The plane of vibration through H is then given by a great circle tangent at H to a straight line parallel to the second position of the plane of vibration through the lower nicol. This intersects the great circle A_1CB_1 in C. On this great circle A_1CB_1 an arc CB_1 is set off equal to the arc CA_1. A great circle HBB_1 is then drawn cutting the great circle which marks the optic axial plane in B. By virtue of the Biot-Fresnel law, the optic axial angle 2V is then read directly by the arc AB.

Dr. Wright, in his recent book on 'The Methods of Petrographic-Microscopic Research',[1] takes exception to Professor Becke's method of

[1] F. E. Wright, Carnegie Institution of Washington, 1911, Publ. No. 158, pp. 158–160.

finding the plane of vibration through the point H, and is of opinion that it is more correctly represented by the great circle passing through H and the intersection C of the polar great circle with the trace of the principal plane of the lower nicol (fig. 2).

The author proposes to avoid this contentious point by the following simple method (fig. 3):—

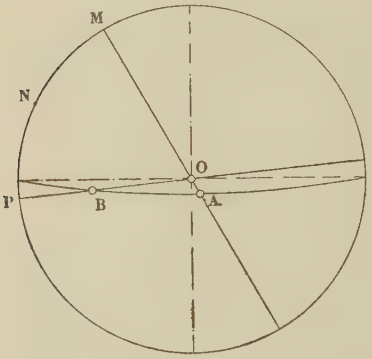


Fig. 3.

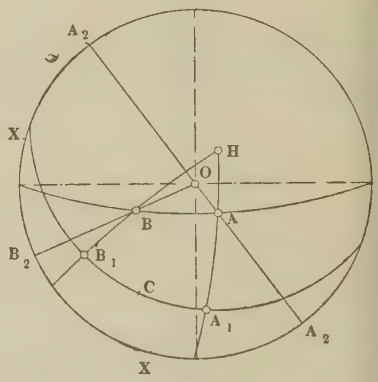


Fig. 4.

Author's method.

Instead of taking a point H on the isogyre the centre of the field O is used. A straight line is drawn from O through the first optic axis A, cutting the circumference of the stereographic circle in M. The position of extinction N is then marked on the circumference of the same circle. From N an arc NP is set off equal to MN. P is then joined to O by a straight line and produced if necessary to cut the great circle marking the optic axial plane in B. The point B will then be the second optic axis.

The advantages that this method would appear to give are the following:—

(1) All doubt is removed as to the correct plane of vibration through H.

(2) Greater ease and accuracy in graphic construction as—

(a) O may be determined with far greater certainty than a point on a more or less clear isogyre.

(b) Only one great circle is necessary to be drawn, the remaining lines being straight.

(c) The line of extinction can be found with considerable accuracy in convergent or parallel light, the latter being no doubt the better.

The method proposed is of no service when the axial plane lies on a diameter, as the line of extinction will then be coincident with it.

It frequently happens that, when the optic axial angle of a thin-section or cleavage-flake of a crystal is required, an optic axis is a little way beyond the field, thus rendering the determination by the Mallard-Becke method impossible. In such a case it is possible to make a fairly good determination by combining Professor Becke's method of obtaining the second optic axis with the method proposed above by the writer (fig. 4). As in Professor Becke's method the optic axial plane is found by placing the isogyre horizontally in an east and west direction. The point H is then fixed precisely as before, and in addition the position of extinction is noted. All these data are transferred, duly corrected for refraction, to a stereographic projection. On this stereographic projection the point C on the great circle polar to H and the position of extinction X on the base circle are marked. Now if A and B be the positions of the optic axes, it is clear, by virtue of the Biot-Fresnel law, that OX will bisect the angle BOA (internally or externally), and also, if B_1 and A_1 be the points where great circles HB and HA cut the great circle polar to H, that $CB_1 = CA_1$. We now proceed to find the points A and B by trial and error. Set off on the base circle a series of equal arcs XA_2, XB_2, and on the polar great circle a series of equal arcs CA_1, CB_1. Trial and error will then determine with a reasonable amount of accuracy which values of A_2, B_2, A_1, and B_1 are to be taken so as to fulfil the necessary condition that OB_2 and HB_1 intersect at B, while OA_2 and HA_1 intersect at A. The procedure need not necessarily be a long one, as inspection of the field gives a rough idea of where the optic axis A is situated.

It is not suggested that the method can compare in accuracy with the case in which one optic axis is visible, but it is claimed that fairly reasonable accuracy may be obtained if no other method can be used. The diagram (fig. 4) is that for a cleavage-flake of labradorite. 2V was found equal to 69°. By using a very wide angle condenser, and thus rendering both axes visible, 2V was determined as 71°.

A (sixth) list of new mineral names.[1]

By L. J. Spencer, M.A., F.G.S.

Assistant in the Mineral Department of the British Museum.

[Communicated March 11, 1913.]

Achiardite. (R. Koechlin, Mineralogisches Taschenbuch der Wiener Mineralogischen Gesellschaft, 1911, pp. 12, 62; Min. Petr. Mitt., 1912, vol. xxxi, p. 91 (Achiardit).) Synonym of Dachiardite (G. D'Achiardi, 1906; 4th list).

Achlusite. W. F. Petterd, 1910. Catalogue of the Minerals of Tasmania, 3rd edit., Hobart, 1910, p. 191; Papers Roy. Soc. Tasmania, 1910, p. 191. A green alteration product of topaz resembling steatite in appearance, but near soda-mica in composition. Derivation not stated, but no doubt from ἀχλύς, mist, alluding to the cloudy alteration of the clear topaz.

Acmite-augite. F. Zambonini, 1910. Mineralogia Vesuviana. Mem. Accad. Sci. Fis. Mat. Napoli, vol. xiv, pp. 153, 155 (acmiteaugite). The same as aegirine-augite (H. Rosenbusch, 1902; 2nd List), but brown in colour.

Aegerite. (Mineral Resources U.S. Geol. Survey, for 1910, 1911, part ii, p. 836.) Trade-name for a bitumen allied to elaterite.

Aeonite. (Mineral Resources U.S. Geol. Survey, for 1909, 1911, part ii, p. 733.) Trade-name for a bitumen very similar to elaterite.

Albanite. C. I. Istrati and M. A. Mihailescu, 1912. Bul. Soc. Române Ştiinţi., vol. xx, p. 626. A bituminous material from Albania.

Allcharite. B. Ježek, 1912. Zeits. Kryst. Min., vol. li, p. 275 (Allcharit). Small, acicular, orthorhombic crystals, resembling stibnite in appearance, found with vrbaite (q.v.) on specimens of realgar and

[1] Previous lists of this series have been given at the ends of vols. xi–xv (1897–1910) of this Magazine. In addition to new names, a few older names, not mentioned in Dana's 'System of Mineralogy' (6th edit., 1892) or A. H. Chester's 'Dictionary of the names of minerals' (1896), are here included. Bibliographical references to some of these have been kindly supplied to me by Dr. R. Koechlin of Vienna.

orpiment from Allchar, Macedonia. Chemical composition not determined. Named after the locality.

Allophanoids. S. J. Thugutt, 1911. Spraw. Tow. Nauk. Warszawa, 1911, vol. iv, p. 222 (alofanoid); Centralblatt Min., 1912, 35 (Allophanoide). Clays of the allophane; halloysite, and montmorillonite groups.

Almeriite. S. Calderón, 1910. Los Minerales de España, vol. ii, p. 206 (Almeriita). A hydrated basic sulphate of aluminium and sodium, $Al_2(SO_4)_3 . Na_2SO_4 . 5Al(OH)_3 . H_2O$, the formula being the same as that of calafatite (q.v.) with sodium in place of potassium. A compact, white material, resembling halloysite in appearance, from Almeria.

Ampangabeite. A. Lacroix, 1912. Compt. Rend. Acad. Sci. Paris, cliv, p. 1044; Bull. Soc. franç. Min., 1912, vol. xxxv, p. 194 (ampangabéite). A tantalo-niobate (containing but little titanium) of uranium, iron, yttrium, &c., occurring as large rectangular (tetragonal or orthorhombic) prisms in pegmatite at Ampangabe, Madagascar. It approximates in composition to the heterogeneous ånnerödite.

Angelardite. A. Lacroix, Minéralogie de la France, 1910, vol. iv, p. 524. The correct form of anglarite (of F. von Kobell, 1831); so named after the locality, Angelard (not Anglar), in the commune of Compreignac, Haute-Vienne, France. A blue, hydrated phosphate of iron usually identified with vivianite, but regarded by Lacroix as representing a distinct species, near to ludlamite.

Angleso-barite. *See* Hokutolite.

Arduinite. E. Billows, 1912. Two pamphlets both dated Padova, 1912, and entitled 'Analisi di alcuni minerali del Veneto, Nota I, Arduinite, un nuovo minerale', but one of 11 pp. and the other of 14 pp. One of them is stated to be an extract from Riv. Min. Crist. Ital., vol. xli, but the paper does not appear in that or in earlier volumes of that periodical. A red, radially fibrous zeolite, $H_{16}Na_4CaAl_2Si_8O_{30}$, from Val dei Zuccanti, Venetia. Named after the Venetian geologist Giovanni Arduino (1714–1795).

Arsenoferrite. H. Baumhauer, 1912. Zeits. Kryst. Min., vol. li, p. 143 (Arsenoferrit). Cubic-dyakisdodecahedral iron arsenide, $FeAs_2$, isomorphous with iron-pyrites; but represented only by pseudomorphous crystals in the gneiss of the Binnenthal, Switzerland.

Arsenomiargyrite. F. M. Jaeger and H. S. van Klooster, 1912. Zeits. Anorg. Chem., vol. lxxviii, p. 265 (Arsenomiargyrit). The arti-

ficially produced sulpharsenite of silver, $AgAsS_2$, corresponding with the sulphantimonite miargyrite. No doubt identical with the mineral smithite (R. H. Solly, 1905; 4th List)

Bababudanite. W. F. Smeeth, [1911 ?]. Rec. Mysore Geol. Dept., for 1907–8, vol. ix, p. 85. A soda-amphibole, $2NaFe'''(SiO_3)_2 . Fe''Mg_3(SiO_3)_4$, closely allied to riebeckite, but differing from this in the slightly greater angle of optical extinction ($a : c' = 7–9°$) and in the character of the pleochroism (a Prussian blue, b purple tending to violet, c yellow with tinge of green). Occurs with cummingtonite in quartz-magnetite-schists in the Bababudan Hills, Kadur district, Mysore.

Baeumlerite. O. Renner, 1912. Centralblatt Min., 1912, p. 106 (Baeumlerit). A colourless, highly deliquescent, and optically biaxial salt, $KCl . CaCl_2$, occurring in the Prussian salt-deposits. Named after — Baeumler, General-Director of the Heldburg Salt Company. F. Zambonini (Centralblatt Min., 1912, 270) suggests that this is identical with the cubic chlorocalcite (of A. Scacchi, 1872) from Vesuvius.

Barbierite. W. T. Schaller, 1910. Amer. Journ. Sci., ser. 4, vol. xxx, p. 358; Bull. Soc. franç. Min., 1910, xxxiii, p. 320; Journ. Washington Acad. Sci., 1911, vol. i, p. 114; Zeits. Kryst. Min., 1912, vol. l, p. 347; Bull. U.S. Geol. Survey, 1912, No. 509, p. 40. Monoclinic soda-felspar ($NaAlSi_3O_8$) isomorphous with orthoclase and dimorphous with albite. The existence of this has been established by the analyses of soda-rich orthoclases (one from Kragerö, Norway, containing only 1·15 per cent. K_2O) made by Philippe Barbier, Professor of Chemistry in the University of Lyons. Compare Cryptoclase.

Bassanite. F. Zambonini, 1910. Mineralogia Vesuviana. Mem. R. Accad. Sci. Fis. Mat. Napoli, ser. 2, vol. xiv, No. 7, p. 327. White, opaque crystals with the form of gypsum, found in blocks ejected in 1906 from Vesuvius. Anhydrous calcium sulphate ($CaSO_4$), differing from anhydrite, and possibly identical with the hexagonal calcium sulphate produced by the artificial dehydration of gypsum. Named after Francesco Bassani, Professor of Geology in the University of Naples.

Batchelorite. W. F. Petterd, 1910. Catalogue of the Minerals of Tasmania, 3rd edit., Hobart, 1910, p. 22; Papers Roy. Soc. Tasmania, 1910, p. 22. A greenish, foliated mineral, from Mt. Lyell mine, Tasmania; it had previously been described as pyrophyllite, which it resembles in appearance, but it differs from this in containing more silica, the formula being approximately $Al_2O_3 . 2SiO_2 . H_2O$. Named in memory of the late Mr. W. T. Batchelor, formerly manager of the Mt. Lyell mine.

Bauerite. F. Rinne, 1911. Ber. k. sächs. Ges. Wiss., Leipzig, Math.-Physis. Kl., vol. lxiii, p. 445 (Bauerit). The crystalline end-product, consisting mainly of hydrated silica, which results from the artificial or natural bleaching (baueritization) of biotite. It retains the form and optically uniaxial character of the original biotite. Named after Professor Max Bauer, of Marburg.

Beaverite. B. S. Butler and W. T. Schaller, 1911. Journ. Washington Acad. Sci., vol. i, p. 26; Amer. Journ. Sci., 1911, ser. iv, vol. xxxii, p. 418; Zeits. Kryst. Min., 1912, vol. l, p. 114; Bull. U.S. Geol. Survey, 1912, No. 509, p. 77. Hydrous sulphate of copper, lead, ferric iron (and aluminium), $CuO . PbO . Fe_2O_3 . 2SO_3 . 4H_2O$, occurring as canary-yellow, earthy and friable masses. Under the microscope it shows minute, six-sided plates. Named from the locality, Beaver County, Utah.

Belmontite. G. Küstel. R. Koechlin, Mineralogisches Taschenbuch der Wiener Mineralogischen Gesellschaft, 1911, p. 16 (Belmontit). A yellow mineral, said to be a silicate of lead, occurring with stetefeldtite at Belmont, Nevada. Named from the locality. A specimen so labelled was presented by Mr. Küstel in 1873 to the Royal Natural History Museum of Vienna.

Betafite. A. Lacroix, 1912. Compt. Rend. Acad. Sci. Paris, vol. cliv, p. 1042; Bull. Soc. franç. Min., 1912, vol. xxxv, pp. 88, 234. A member of a group of cubic minerals, niobo-tantalo-titanates of uranium, &c., including also blomstrandite (of G. Lindström, 1874) and samiresite (q.v.); they are closely allied to pyrochlore and hatchettolite, but differ from the former in containing only little lime and rare earths, and from the latter in containing titanium. Betafite is a hydrated niobate and titanate of uranium, and occurs in pegmatite near Betafo in Madagascar. Named after the locality.

Binarite. An obsolete synonym of marcasite. Named, no doubt, from the Latin binarius, since the crystals are usually twinned. The German form Binarkies, attributed to Weiss, appears in the textbooks of Glocker (1831, p. 452), Hartmann, and Quenstedt. The form Binarit is quoted by A. Frenzel, Mineralogisches Lexicon für das Königreich Sachsen, 1874, p. 197.

Biopyribole. A. Johannsen, 1911. Journ. Geol. Chicago, vol. xix, p. 319. A contraction of the words biotite, pyroxene, and amphibole, suggested for use as a group name. Similarly, Pyribole (q.v.).

Brocchite. A. Scacchi, 1840. Annali Civili del Regno delle Due Sicilie, Napoli, vol. xxiii, p. 15; Mem. R. Accad. Sci. Napoli, Classe delle Sci. Nat., 1852, vol. vi, p. 268; Ann. Chem. Phys. (Poggendorff), 1853, Erg.-Band iii, p. 183. A synonym of chondrodite. It was applied by Scacchi to his 'Type II' of humite. Named after Giovanni Battista Brocchi (1772–1826).

Calafatite. S. Calderón, 1910. Los Minerales de España, vol. ii, p. 205 (Calafatita). A hydrated basic sulphate of aluminium and potassium, containing rather more water than alunite: formula $Al_2(SO_4)_3 . K_2SO_4 . 5Al(OH)_3 . H_2O$. As white compact masses it occurs abundantly in Almeria. Named after Mr. Juan Calafat León, of the Museum of Natural Sciences, Madrid.

Calciocancrinite. F. Zambonini, 1910. Mineralogia Vesuviana. Mem. R. Accad. Sci. Fis. Mat. Napoli, ser. 2, vol. xiv, No. 7, p. 202. Synonym of Kalkcancrinit (J. Lemberg, 1876) and lime-cancrinite (Dana, System, 1892, p. 428).

Calciodialogite. T. Nicolau, 1910. Synonym of Calciorhodochrosite (q.v.).

Calciorhodochrosite. T. Nicolau, 1910. Anuarul Inst. Geol. României, vol. iii, p. 39 (Calciorhodochrosită, Calciodialogită), p. 41 (Germ., Calziorhodochrosit, Calziodiallogit). Mixed carbonates of manganese and calcium, occurring intimately intermixed with rhodonite in manganese ore from Roumania.

Canadium. A. G. French, 1911. Chem. News, vol. civ, p. 283. An alleged new element of the platinum group, said to have been found as white crystalline grains in the Nelson district, British Columbia, Canada. Named after the country of origin. This reported discovery has not been confirmed (Ann. Rep. Minister of Mines, British Columbia, for 1911, 1912, pp. 157, 165; Mining Journ. London, 1913, vol. ci, p. 344).

Catalinite. (D. B. Sterrett, Mineral Resources U. S. Geol. Survey for 1910, 1911, part ii, p. 898.) Local trade-name for beach pebbles, used as gems, from Santa Catalina Island, California.

Chizeuilite. A. Lacroix, 1910. Minéralogie de la France, vol. iv, pp. 594, 905. A supposed new mineral afterwards identified with andalusite. Occurs as colourless prisms at Chizeuil, near Chalmoux, Saône-et-Loire.

Chlor-spodiosite. F. K. Cameron and W. J. McCaughey, 1911.

Journ. Physical Chem., Ithaca, N.Y., vol. xv, p. 464. The chlorine analogue, $Ca_3(PO_4)_2 . CaCl_2$, of spodiosite, prepared artificially as orthorhombic crystals. The natural mineral is distinguished as fluor-spodiosite.

Chlor-utahlite. (D. B. Sterrett, Mineral Resources U.S. Geol. Survey, for 1908, 1909, part ii, p. 853.) The same as utahlite (G. F. Kunz, 1895; 1st List), the prefix being, no doubt, added because of the characteristic green colour of the stone. A synonym of variscite.

Chrom-brugnatellite. L. Hezner, 1912. Centralblatt Min., 1912, p. 570 (Chrom-Brugnatellit). A scaly, violet mineral occurring in serpentine at Dundas, Tasmania. In composition, $2MgCO_3 . 5Mg(OH)_2 . 2Cr(OH)_3 . 4H_2O$, it is analogous to brugnatellite with chromium in place of iron. Possibly identical with stichtite (q.v.).

Chromopicotite. A. Lacroix, 1910. Minéralogie de la France, vol. iv, p. 311. The same as Chrompicotite (T. Petersen, 1869). A member of the spinel group intermediate between chromite and picotite, the formula being $(Fe,Mg)(Cr,Al)_2O_4$.

Cliachite. J. F. A. Breithaupt, 1847. Handbuch d. Mineralogie, vol. iii, p. 896 (Picites Cliachites; Cliachit). A ferruginous bauxite from Cliache (= Kljake) in Dalmatia. F. Cornu in 1909 (5th list) used this name (Kliachite) for the colloidal aluminium hydroxides occurring in bauxite. *See* Kljakite and Sporogelite.

Cobaltoadamite. A. Lacroix, 1910. Minéralogie de la France, vol. iv, p. 424. A variety of adamite from Cape Garonne, Var, of a pale rose-red to carmine colour, and containing some cobalt isomorphously replacing zinc (analysed by A. Damour, 1868).

Cokeite. A. Lacroix, 1910. Minéralogie de la France, vol. iv, p. 648 (cokéite). The same as carbonite. A native coke produced by the action of igneous intrusions or of earth movements on coal-seams, or by the spontaneous combustion of coal.

Críptosa. (S. Calderón, Los Minerales de España, 1910, vol. ii, p. 474.) Spanish form of Cryptoclase (q.v.).

Cryptoclase. V. Souza-Brandão, 1909. Communic. Commissão do Serviço Geologico de Portugal, vol. vii, p. 137 (Fr. cryptose; Germ. Kryptoklas). A variety of albite which by repeated twinning according to the albite-law simulates monoclinic symmetry. It bears the same relation to albite that orthoclase does to microcline. Anorthoclase belongs

to the isomorphous series of which orthoclase and cryptoclase are the end-members.

Cuproadamite. A. Lacroix, 1910. Minéralogie de la France, vol. iv, p. 424. A variety of adamite from Cape Garonne, Var, of a sea-green colour and containing much copper (analysed by F. Pisani, 1870), thus forming a passage to the isomorphous mineral olivenite.

Cuprocuprite. V. I. Vernadsky, 1910. Opuit opisatelnoĭ Mineralogii, St. Petersburg, vol. i, part 3, p. 416 (купрокуприть); Centralblatt Min., 1912, p. 760 (Cuprocuprit). Native copper containing admixed or dissolved cuprous oxide ($Cu + Cu_2O$).

Delatynite. J. Niedźwiedzki, 1908. Kosmos, Lemberg, vol. xxxiii, p. 531 (delatynit), p. 535 (Delatinit). A variety of amber from Delatyn in the Galician Carpathians, differing from succinite in containing rather more carbon (79·93 per cent.), less succinic acid (0·74–1·67 per cent.), and no sulphur.

Diocroma. A. Scacchi (unpublished note read at Accad. Sci. Naples, April 27, 1841). F. Zambonini, Mineralogia Vesuviana. Mem. R. Accad. Sci. Fis. Mat. Napoli, 1910, ser. 2, vol. xiv, No. 7, pp. 270, 271 (diocroma). A name applied to the small crystals of zircon from Monte Somma which change in colour, when heated, from sky-blue to orange-yellow.

Egueiite. A. Lacroix, 1910. Minéralogie de la France, vol. iv, p. 536 (eguéïite). G. Garde, Description géologique des régions situées entre le Niger et le Tchad, Paris, 1911, p. 263 (Egueïite), p. 264 (égueïite). Described without name by G. Garde, Compt. Rend. Acad. Sci. Paris, 1909, vol. cxlviii, p. 1618. A hydrated basic phosphate of ferric iron with a little calcium and aluminium, occurring as small nodules, with a fibro-lamellar internal structure, embedded in clay in Eguei, Sudan. It is allied to borickite and foucherite (q.v.), and is probably an altered vivianite.

Eichbergite. O. Grosspietsch, 1911. Centralblatt Min., 1911, p. 433 (Eichbergit). A massive iron-grey mineral, $(Cu,Fe)_2S \cdot 3(Bi,Sb)_2S_3$, from the magnesite deposits of Eichberg, Semmering Pass, Austrian Alps.

Epinatrolite. S. J. Thugutt, 1911. Centralblatt Min., 1911, p. 408 (Epinatrolith). A less stable form of natrolite which loses its water at a lower temperature, but is otherwise identical in morphological and optical characters and chemical composition with normal natrolite. The dis-

tinction is based on the micro-chemical colouring reactions with the partially dehydrated material.

In the slightly earlier Polish publications (Spraw. Tow. Nauk. Warszawa, 1910, vol. iii, p. 414; 1911, vol. iv, p. 77) the author used the term *metanatrolite* for this modification; but as this name had been previously used by F. Rinne in 1890 for partially dehydrated natrolite, he renamed it epinatrolite.

Estramadurite. (H. E. Roscoe and C. Schorlemmer, Treatise on Chemistry, 1877, vol. i, p. 459 (estramadourite); 1878, vol. ii, part 1, p. 205 (estramadurite). T. E. Thorpe, Dictionary of Applied Chemistry, 1890, vol. i, p. 402; vol. iii, p. 184.) 'Phosphorite and estramadurite are massive varieties of apatite which occur in Estramadura [i.e. Estremadura or Extremadura], in Spain' (Roscoe and Schorlemmer, 1878).

Fasernephrit. J. Uhlig, 1910. Neues Jahrb. Min., 1910, vol. ii, p. 91. The nephrite of this newly discovered occurrence in the Radauthal, Harz, shows in part a fibrous structure owing to the parallel, rather than matted, aggregation of the actinolite fibres. This material has already been described under the name nephritoid (J. Fromme, 1909; 5th List).

Ferrite. H. M. Howe, 1890. The Metallurgy of Steel, New York, vol. i, pp. 164, 165. Pure or nearly pure metallic iron detected under the microscope as a crystalline constituent of manufactured iron and steel. The same term has been applied by V. I. Vernadsky (Opuit opisatelnoĭ Mineralogii, St. Petersburg, 1908, vol. i, pp. 156, 162 (Феррит); Centralblatt Min., 1912, 759 (Ferrit)) to native iron; for example, the terrestrial iron from Uifak, Disko Island, Greenland.

Unfortunately, however, the name ferrite had been earlier used in different senses. Chemically, it signifies a salt in which ferric oxide plays the part of an acid; for example, barium ferrite, $BaFe_2O_4$. Mineralogically, it was used by H. Vogelsang in 1872 for an amorphous iron hydroxide of unknown composition occurring as red and yellow patches in decomposed igneous rocks; and by M. F. Heddle in 1882 for ferruginous pseudomorphs after olivine.

Ferritungstite. W. T. Schaller, 1911. Journ. Washington Acad. Sci., vol. i, p. 24; Amer. Journ. Sci., 1911, ser. 4, vol. xxxii, p. 161; Zeits. Kryst. Min., 1912, vol. l, p. 112; Bull. U.S. Geol. Survey, 1912, No. 509, p. 83. A yellow ochre closely resembling tungstite (tungstic-ochre), but consisting of hydrated ferric tungstate, $Fe_2O_3 . WO_3 . 6H_2O$.

Under the microscope it shows minute hexagonal plates which are optically isotropic on the base. Occurs as an alteration-product of wolframite in the State of Washington.

Ferrobrucite. A. Lacroix, 1909. Minéralogie de la France, vol. iii, p. 402. Brucite (MgO_2H_2) containing a small amount of ferrous oxide. The same as Eisenbrucit of F. von Sandberger, 1880.

Ferronemalite. A. Fersmann, 1911. Bull. Acad. Sci. St.-Pétersbourg, ser. 6, vol. v, p. 551 (Ферронемалить). Abstract in Chem. Zentralblatt, 1911, vol. i, p. 1879 (Ferronemalith). A variety of nemalite from Caucasus containing some ferrous oxide (FeO 5 per cent.). *See* Ferrobrucite.

Ferropicotite. A. Lacroix, 1910. Minéralogie de la France, vol. iv, p. 306. A variety of spinel differing from picotite in containing ferric oxide in place of chromic oxide, the formula being $(Fe,Mg)(Al,Fe)_2O_4$.

Ferroplatinum. V. I. Vernadsky, Opuit opisatelnoĭ Mineralogii, St. Petersburg, 1908, vol. i, p. 156 (Ферроплатина); Centralblatt Min., 1912, p. 759 (Ferroplatin). Synonym of Eisenplatin of Breithaupt (1832) = Iron-platinum (Dana, 1854).

Flajolotite. A. Lacroix, 1910. Minéralogie de la France, vol. iv, p. 509. A compact or earthy mineral of a lemon-yellow colour occurring abundantly as large nodular masses at Hammam N'Baïl, Constantine, Algeria. A hydrated antimonate of iron, $4FeSbO_4 . 3H_2O$, analysed by — Flajolot in 1871.

Fluocollophanite. A Lacroix, 1910. Minéralogie de la France, vol. iv, p. 561 (fluocolophanite). A variety of collophanite containing fluorine, the formula being given as

$$\begin{cases} x[Ca_3(PO_4)_2] + y\,CaCO_3 + z\,H_2O \\ x(CaF)_2Ca_8(PO_4)_6 + y\,CaCO_3 + z\,H_2O \end{cases}$$

It is amorphous (colloidal) and optically isotropic, and is an important constituent of the calcium phosphates of sedimentary origin. Colophanite is an error for collophanite (Kollophan of F. von Sandberger, 1870), from *κόλλα*, glue (Fr. colle) and *φαίνεσθαι*, to appear. *See* Quercyite.

Fluor-spodiosite. F. K. Cameron and W. J. McCaughey, 1911. Journ. Physical Chem., Ithaca, N.Y., vol. xv, p. 470. Synonym of spodiosite. *See* Chlor-spodiosite.

Foucherite. A. Lacroix, 1910. Minéralogie de la France, vol. iv, p. 535 (fouchérite). The correct spelling of fucherite (A. Leymerie,

1867), an amorphous hydrated basic phosphate of ferric iron with some aluminium and calcium; from Fouchères, Aube, France. Possibly identical with borickite (J. D. Dana, 1868).

Gageite. A. H. Phillips, 1910. Amer. Journ. Sci., ser. 4, vol. xxx, p. 283. Radiating aggregates of colourless, acicular crystals, associated with leucophoenicite, zincite, willemite, and calcite at Franklin, New Jersey. $8(Mn,Mg,Zn)O \cdot 3SiO_2 \cdot 2H_2O$; related to leucophoenicite (S. L. Penfield and C. H. Warren, 1899). Named after Mr. R. B. Gage, of Trenton, New Jersey, who collected and analysed the material.

Gajite. F. Tućan, 1911. Centralblatt Min., 1911, p. 312 (Gajit). A snow-white, compact mineral from Croatia, resembling magnesite in appearance. It is a hydrated carbonate of calcium and magnesium, similar in composition to the rocks pencatite and predazzite (mixtures of calcite and hydromagnesite), but it is apparently homogeneous. Under the microscope it shows a finely granular texture with the cleavage and optical characters of the rhombohedral carbonates. Named after Ljudevit Gaj (1809–72), a Croatian leader.

Glacialite. (18th Ann. Rep. U.S. Geol. Survey for 1896–7, 1897, part v, p. 1354. G. P. Merrill, Rep. U.S. National Museum for 1899, 1901, p. 337.) Trade-name for a white clay from Enid, Oklahoma, put on the American market as a fuller's earth.

Goldfieldite. F. L. Ransome, 1909. United States Geol. Survey, Prof. Paper No. 66, p. 116; Economic Geology, 1910, vol. v, p. 453. A massive, dark lead-grey mineral occurring with marcasite, bismuthinite, famatinite, and native gold in the gold ores of Goldfield, Nevada. A cupric sulphantimonite in which part of the antimony is replaced by bismuth (and arsenic) and part of the sulphur by tellurium (17 per cent.); $5CuS \cdot (Sb,Bi)_2(S,Te)_3$. Named after the locality.

Guadarramite. J. Muñoz del Castillo, 1906. Bol. Soc. Española Hist. Nat., vol. vi, p. 479 (Guadarramita). S. Calderón, Los Minerales de España, 1910, vol. i, p. 323. A radioactive variety of ilmenite from the Sierra de Guadarrama, Castille, Spain.

Haematogelite. F. Tućan, 1913. Centralblatt Min., 1913, p. 68 (Hämatogelit). A colloidal form of ferric oxide (Fe_2O_3), occurring as the colouring material of bauxite. *See* Sporogelite.

Hatchite. R. H. Solly and G. F. H. Smith, 1912. Mineralogical Magazine, vol. xvi, p. 287. Minute, lead-grey, anorthic crystals of undetermined composition (but suggested to be a sulpharsenite of lead)

from the crystalline dolomite of the Binnenthal, Switzerland. Named after Dr. Frederick Henry Hatch.

Heliodor. (E. Kaiser, Centralblatt Min., 1912, p. 385.) Trade-name for a golden beryl of gem-quality from German South-West Africa.

Hexahydrite. R. A. A. Johnston, 1911. Summary Rep. Geol. Surv. Canada, for 1910, p. 256. A hydrated magnesium sulphate containing less water (47·33 per cent.) than epsomite, and identical in composition with the artificially prepared hexahydrate $MgSO_4 . 6H_2O$. As a white, columnar to fibrous material it forms seams in an altered rock in the Lillooet district, British Columbia.

Hinsdalite. E. S. Larsen, Junr. and W. T. Schaller, 1911. Journ. Washington Acad. Sci., vol. i, p. 25; Amer. Journ. Sci., ser. 4, vol. xxxii, p. 251; Bull. U.S. Geol. Survey, 1912, No. 509, p. 66; Zeits. Kryst. Min., 1912, vol. l, p. 101. Hydrous sulphate and phosphate of lead (and strontium) and aluminium, $PbSO_4 . AlPO_4 . 2Al(OH)_3$, isomorphous with svanbergite and beudantite. It forms dark-grey, granular masses, and colourless, rhombohedral crystals. Named from the locality, Hinsdale County, Colorado.

Hokutolite. K. Jimbō, 1913. Bull. Soc. franç. Min., 1912 [i.e. 1913], vol. xxxv, p. 471; Amer. Journ. Sci., 1913, ser. 4, vol. xxxv, p. 464. A mixture, in variable proportions, of lead sulphate and barium sulphate deposited as a crystalline crust by the Hokuto hot springs in Taiwan (= Formosa). It was described as a radioactive mineral by Y. Okamoto (first in Japanese, and afterwards in English in Beiträge zur Mineralogie von Japan, 1912, No. 4, p. 178), and again by M. Hayakawa and T. Nakano (Zeits. Anorg. Chem., 1912, vol. lxxviii, p. 183), the latter authors applying to it the name *angleso-barite* (p. 183) and, in German, Angleso-Baryt (pp. 184, 190).

Hydromelanothallite. F. Zambonini, 1910. Mineralogia Vesuviana. Mem. R. Accad. Sci. Fis. Mat. Napoli, ser. 2, vol. xiv, No. 7, p. 57 (idromelanotallite). The black scales of melanothallite (A. Scacchi, 1870) change on exposure to the air to green, and for this alteration-product the name hydromelanothallite is proposed. Scacchi's analyses suggest that the former may be $CuCl_2 . CuO . H_2O$ and the latter $CuCl_2 . CuO . 2H_2O$.

Hydrotroilite. M. Sidorenko, 1901. Mém. Soc. Nat. Nouv.-Russ. Odessa, vol. xxiv, part i, p. 119 (*идротроилитъ*); Abstract in Neues Jahrb. Min., 1902, vol. ii, Ref. p. 397 (Hydrotroilit). Hydrated iron sulphide, $FeS . H_2O$, occurring in the black mud of inland seas.

Hydroxyapatite. W. T. Schaller, 1912. Bull. U.S. Geol. Survey, No. 509, p. 100. A hypothetical constituent of apatite, $9CaO . 3P_2O_5 . CaO . H_2O$, corresponding with fluor-apatite $9CaO . 3P_2O_5 . CaF_2$. Compare Voelckerite.

Hyposiderite. A. Breithaupt, 1847. Handbuch der Mineralogie, vol. iii, p. 894 (Picites Hyposiderites; Hyposideriţ). A black, shining variety of limonite differing from stilpnosiderite in its lower specific gravity (3·30–3·38) and higher percentage of water (20 per cent.). Named from *ὑπό*, less, and *σίδηρος*, iron.

Idromelanotallite. *See* Hydromelanothallite.

Imerinite. A. Lacroix, 1910. Minéralogie de la France, vol. iv, p. 787. A soda-amphibole containing only a small amount of sesquioxides and so allied to soda-richterite. It occurs as colourless to blue needles, resembling tremolite in appearance, in crystalline limestone in the central province Imerina of Madagascar.

Kinradite. (D. B. Sterrett, Gems and precious stones in 1911, Mineral Resources of the United States, for 1911, 1912, p. 27 of advance copy.) Local trade-name for a spherulitic jasper-like quartz from California. Named after Mr. J. J. Kinrade, of San Francisco.

Kljakite. F. Tućan, Neues Jahrb. Min., 1912, Beil.-Bd. xxxiv, p. 411; M. Kišpatić, tom. cit., pp. 519, 534 (Kljakit). An alternative spelling of Cliachite (q.v.) and Kliachite (5th list). *See* Sporogelite.

Kryptoklas. *See* Cryptoclase.

Lassolatite. F. Gonnard, 1876. Minéralogie du département du Puy-de-Dôme, p. 9; A. Lacroix, Minéralogie de la France, 1901, vol. iii, p. 321. A fibrous, silky variety of opal, identical with fiorite. From the puy de Lassolas, Puy-de-Dôme.

Lefkasbestos. A. Zdarsky, 1910. Zeits. prakt. Geol., vol. xviii, p. 345 (Lefkasbest). A bleached chrysotile occurring in weathered serpentine at Mount Troodos, Cyprus. Named from *λευκός*, white, and *ἄσβεστος*.

Losite. A. Lacroix, 1911. Les syénites néphéliniques de l'archipel de Los et leurs minéraux. Nouv. Arch. Muséum, Paris, ser. 5, vol. iii, p. 37; Bull. Soc. franç. Min., 1912, vol. xxxv, p. 7. An undetermined mineral detected in thin sections of the nepheline-syenite of the Los Islands, West Coast of Africa. It is optically uniaxial and possibly related to cancrinite, but has a lower negative birefringence than this.

Lublinite. J. Morozewicz, 1907. Kosmos, Lemberg, vol. xxxii, p. 487; Centralblatt Min., 1911, p. 229. P. N. Čirvinskij (P. Tschirwinsky), Mitt. Ges. Naturf. Kiew, 1910, vol. xxi, p. 285; Doelter's Handbuch der Mineralchemie, 1911, vol. i, p. 360. (*See* 5th List, where the name is incorrectly attributed to another author.)

Magnesiochromite. A. Lacroix, 1910. Minéralogie de la France, vol. iv, p. 311 (magnésiochromite). The same as magnochromite (G. M. Bock, 1868). A variety of chromite containing magnesium, $(Fe,Mg)Cr_2O_4$.

Manandonite. A. Lacroix, 1912. Compt. Rend. Acad. Sci. Paris, vol. clv, p. 446; Bull. Soc. franç. Min., vol. xxxv, p. 223. A borosilicate, $H_{24}Li_4Al_{14}B_4Si_6O_{53}$, occurring as pearly six-sided scales with micaceous cleavage, in corrosion cavities with rubellite in pegmatite near the Manandona river, Madagascar.

Manganobrucite. A. Lacroix, 1909. Minéralogie de la France, vol. iii, p. 402. The same as manganbrucite (L. J. Igleström, 1882), a variety of brucite containing manganese.

Maucherite. F. Grünling, 1913. Centralblatt Min., 1913, p. 225 (Maucherit). A nickel arsenide, Ni_3As_2, forming reddish silver-white, platy crystals (tetragonal or orthorhombic ?) resembling rammelsbergite. It occurs with niccolite in the Kupferschiefer of Eisleben, Thuringia. Named after Mr. Wilhelm Maucher of Munich.

Mauleonite. A. Leymerie, 1867. Cours de Minéralogie, 2nd edit., vol. ii, p. 243 (Mauléonite). A. Lacroix, Minéralogie de la France, 1895, vol. i, p. 383, 1910, vol. iv, p. 739. A white chlorite identical with the leuchtenbergite variety of clinochlore. From Mauléon, Basses-Pyrénées.

Mellonite. L. Palmieri, 1873. Rend. Accad. Sci. Fis. Mat. Napoli, Anno xii, p. 94. F. Zambonini, Mineralogia Vesuviana. Mem. Accad. Sci. Fis. Mat. Napoli, 1910, ser. 2, vol. xiv, No. 7, p. 50. Impure pseudocotunnite, or a mixture of chlorides and sulphates of sodium, potassium, copper, and lead. Named after Professor Macedonio Melloni (1798–1854) of Naples.

Melnikovite. B. Doss, 1911. Annuaire Géol. Min. Russie, vol. xiii, p. 130 (мельниковитъ), p. 139 (Melnikowit); Neues Jahrb. Min., 1912, Beil.-Bd. xxxiii, p. 683; Zeits. prakt. Geol., 1912, vol. xx, p. 453. A labile form of iron disulphide (FeS_2) occurring as minute, black, magnetic grains in Miocene clay on the estates of the Brothers Melnikov in govt. Samara, Russia. It is more readily attacked by chemical reagents than

is iron-pyrites, and it is regarded as having been derived from a colloidal form of iron sulphide.

Metanatrolite. *See* Epinatrolite.

Metathenardite. A. Lacroix, 1910. Minéralogie de la France, vol. iv, p. 32 (métathénardite). At temperatures above 200° C. thenardite (Na_2SO_4) becomes transformed into one or more different crystalline modifications; the latter on cooling may exist in a metastable state for some days at the ordinary temperature. Clear crystals of metathenardite collected from the hot fumaroles of Mt. Pelée, Martinique, gradually became cloudy and white, with a change in their optical characters, due to the transformation into an aggregate of differently orientated crystals of thenardite.

Millosevichite. U. Panichi, 1913. Rend. R. Accad. Lincei, Roma, ser. 5, vol. xxii, sem. 1, p. 303. Normal ferric and aluminium sulphate occurring as an encrustation with a delicate violet colour and vitreous lustre in the Alum Grotto, on the Island of Vulcano, Lipari Islands. Named after Professor Federico Millosevich, of Florence.

Minguetite. A. Lacroix, 1910. Bull. Soc. franç. Min., vol. xxxiii, p. 273; Minéralogie de la France, 1910, vol. iv, p. 738 (minguétite). A black micaceous mineral, previously described as biotite, from the Minguet iron-mine, near Segré (Maine-et-Loire). In composition, $17SiO_2 . 4(Fe,Al)_2O_3 . 8(Fe,Mg)O . (K,Na)_2O . 8H_2O$, it is intermediate between the iron-mica lepidomelane and the iron-chlorite stilpnomelane.

Molengraaffite. H. A. Brouwer, 1911. Centralblatt Min., p. 129 (Molengraaffit). A titano-silicate of calcium, sodium, &c., forming yellowish-brown, monoclinic prisms with a perfect orthopinacoidal cleavage, and resembling astrophyllite in appearance. It occurs as a constituent of the rock lujaurite associated with the nepheline-syenites of the Pilandsberg, Transvaal. Named after Professor Gustaaf Adolf Frederik Molengraaff, of Delft, Holland.

Molybdosodalite. F. Zambonini, 1910. Mineralogia Vesuviana. Mem. R. Accad. Sci. Fis. Mat. Napoli, ser. 2, vol. xiv, No. 7, pp. 214, 358 (molibdosodalite). The green sodalite from Monte Somma was found by G. Freda in 1878 to contain molybdenum (MoO_3, 2·87 per cent.) and a deficiency of chlorine (2·28 per cent.).

Morganite. G. F. Kunz, 1911. Amer. Journ. Sci., ser. 4, vol. xxxi, p. 81; Mineral Industry, for 1910, 1911, vol. xix, p. 583. Trade-name

for a rose-coloured beryl of gem-quality occurring with lithium-bearing minerals in the pegmatites of Madagascar and California. Named after John Pierpont Morgan (1837–1913) of New York City. The same name had earlier been used for the manufactured products of the Morgan Crucible Company in London. Further, the variety-name vorobyevite (5th list) had been previously applied to the pink alkali-bearing beryl from Madagascar.

Mosesite. F. A. Canfield, W. F. Hillebrand, and W. T. Schaller, 1910. Amer. Journ. Sci., ser. 4, vol. xxx, p. 202; Zeits. Kryst. Min., 1911, vol. xlix, p. 1; Bull. U.S. Geol. Survey, 1912, No. 509, p. 104; F. A. Canfield, School of Mines Quart., New York, 1913, vol. xxxiv, p. 276. A mercurous-ammonium compound containing chlorine and sulphate. It was found at Terlingua, Texas, as minute, canary-yellow octahedra and spinel-twins; and is very similar in composition and appearance to kleinite (4th list; = mercurammonite, 5th list) from the same locality. Named after Professor Alfred Joseph Moses, of Columbia University, New York.

Muthmannite. F. Zambonini, 1911. Zeits. Kryst. Min., vol. xlix, p. 246 (Muthmannit). C. Gastaldi, Rend. Accad. Sci. Fis. Mat. Napoli, 1911, ser. 3, vol. xvii, p. 26. Monotelluride of silver and gold, (Ag,Au)Te, hitherto confused with krennerite (a ditelluride, $AuTe_2$, containing but little silver). Named after Dr. Wilhelm Muthmann, Professor of Inorganic Chemistry in the Technical High School at Munich.

Myrickite. (D. B. Sterrett, Gems and precious stones in 1911, Mineral Resources of the United States, for 1911, 1912, p. 7 of advance copy.) Local trade-name for a variety of chalcedony from San Bernardino Co., California. It shows red spots on a grey ground and resembles 'St. Stephen's stone'. Named after Mr. F. M. Myrick, of Randsburg, California.

Naphthine, Naphteine, or Naphtine. A. N. Desvaux, 1834. Mém. Soc. Agric. Sci. & Arts, Angers, 1834, vol. ii, p. 139 (Naphtéine); Bull. Soc. Géol. France, 1835, vol. vi, p. 139 (Naphthine). A. Lacroix, Minéralogie de la France, 1910, vol. iv, p. 619 (Naphtine). A mineral-wax, identical with hatchettite, found in cavities in limestone at Beaulieu, dép. Maine-et-Loire. So named because it has an odour like that of naphtha.

Napoleonite. An obsolete synonym of orthoclase. The name appears in T. Thomson's Outlines of Mineralogy, 1836, vol. i, p. 291, and in the

first to fourth editions (1837–54) of Dana's System of Mineralogy. The same name was later applied to the orbicular diorite, or corsite, of Corsica. In T. Egleston's Catalogue of Minerals and Synonyms, 1892, it appears as a synonym of amphibole.

Natramblygonite. W. T. Schaller, 1911. Amer. J. Sci., ser. 4, vol. xxxi, p. 48; Zeits. Kryst. Min., 1911, vol. xlix, p. 233; 1912, vol. li, p. 246 (Natronamblygonit); Bull. U.S. Geol. Survey, 1912, No. 509, p. 101. A soda-amblygonite occurring as greyish-white cleavage-masses in pegmatite near Canyon City, Colorado. It differs from ordinary amblygonite in that the lithium is largely replaced by sodium (Na_2O, 11·23 per cent.), the formula being $(Na,Li)Al(OH,F)PO_4$.

Natrodavyne. F. Zambonini, 1910. Mineralogia Vesuviana. Mem. R. Accad. Sci. Fis. Mat. Napoli, ser. 2, vol. xiv, No. 7, p. 188 (natrodavyna). Hexagonal crystals, rich in faces, hitherto referred to nepheline or to davyne, but on analysis found to differ from the members of the davyne-microsommite group in containing no potassium and much carbon dioxide.

Natronamblygonit. *See* Natramblygonite.

Natronmelilith. W. C. Brögger, 1898. Die Eruptivgesteine des Kristianiagebietes, III. Vidensk.-Selsk. Skrifter, Math.-Naturv. Kl., Kristiania, for 1897, No. 6, p. 69. A melilite-like mineral occurring in the rock farrisite; afterwards (loc. cit., p. 367) suggested to belong to the scapolite group.

Neocolemanite. A. S. Eakle, 1911. Bull. Dep. Geol. Univ. California, vol. vi, No. 9, p. 179. Described as a variety of colemanite, $2CaO \cdot 3B_2O_3 \cdot 5H_2O$, differing slightly in the angles of the crystals and in optical orientation; but proved by A. Hutchinson (Mineralogical Magazine, 1912, vol. xvi, p. 239) to be identical with colemanite.

Nicholsonite. G. M. Butler, 1913. Economic Geology, vol. viii, p. 8. A variety of aragonite containing up to 10 per cent. of zinc, from Leadville, Colorado. Named after Mr. S. D. Nicholson of the Western Mining Company.

Orthomimic Felspars. V. Souza-Brandão, 1909. Communic. Commissão do Serviço Geologico de Portugal, vol. vii, p. 136 (feldspaths orthomimiques). Triclinic felspars which by repeated twinning (orthomimie, orthomimicry) simulate a higher degree of symmetry with rectangular cleavages. They include orthoclase, anorthoclase, and cryptoclase (q.v.).

Oxy-apatite. A. F. Rogers, 1912. *See* Voelckerite.

Palaeo-albite, &c. T. Scheerer, 1854. Ann. Phys. Chem. (Poggendorff), vol. xci, p. 379 (Paläo-Albit). Following Haidinger (*see* Palaeo-amphibole), the following additional names are given for the original minerals of what were believed to be paramorphs: Paläo-Albit, Paläo-Oligoklas-Albit (p. 379), Paläo-Krokydolith (p. 383), Paläo-Epidot (p. 387). Scheerer regarded albite and scapolite as dimorphous, and the pseudomorphous crystals from Norway as paramorphs of albite after scapolite. His palaeo-albite is therefore a synonym of scapolite. V. M. Goldschmidt (Vidensk.-Selsk. Skrifter, Math.-Naturv. Kl., Kristiania, 1911, No. 1, pp. 309, 312) incorrectly applies the name 'Paläoalbit' to the pseudomorphous crystals themselves.

Palaeo-amphibole, &c. W. Haidinger, 1854. Sitzungsber. Akad. Wiss. Wien, vol. xi (Jahrg. 1853), p. 399 (Paläo-Amphibol). This and other similar names (Paläo-Krystalle (p. 397), Paläo-Natrolith (p. 398), Paläo-Calcit (p. 399), Paläo-Uralit (p. 399)) are suggested for the original minerals of paramorphs; palaeo-amphibole and palaeo-calcite are therefore synonyms of pyroxene and aragonite, respectively.

Palaite. W. T. Schaller, 1912. Journ. Washington Acad. Sci., vol. ii, p. 144. A flesh-coloured hydrous manganese phosphate, $5MnO \cdot 2P_2O_5 \cdot 4H_2O$, probably monoclinic; resulting from the alteration of lithiophilite in the gem-tourmaline mines at Pala, San Diego Co., California. Named after the locality.

Para-orthose. (V. Souza-Brandão, Communic. Commissão do Serviço Geologico de Portugal, 1909, vol. vii, p. 136.) A French form of par-orthoclase (German, Parorthoklas, F. Zirkel, 1893; 2nd List). A synonym of anorthoclase (French, anorthose).

Permutite. (Chem. Zentralblatt, 1907, vol. ii, pp. 363, 1664; 1908, vol. ii, p. 988; 1909, vol. i, p. 2031, &c.) Trade-name for an artificial zeolite-like substance approximating to $Na_2O \cdot Al_2O_3 \cdot 2SiO_2 \cdot 6H_2O$ in composition; employed in water purification and sugar refining. Evidently named from the Latin permuto, to change completely.

Pilbarite. E. S. Simpson, 1910. Chem. News, vol. cii, p. 283; Journ. Nat. Hist. Sci. Soc. Western Australia, 1911, vol. iii, p. 130. A canary-yellow, amorphous (and pseudomorphous) mineral consisting of hydrated silicate of thorium, uranium, and lead, $ThO_2 \cdot UO_3 \cdot PbO \cdot 2SiO_2 \cdot 2H_2O + 2H_2O$, and differing from thorogummite and mackintoshite in the relative proportions of these consti-

tuents. It is found as earthy nodules in the Pilbara goldfield, Western Australia.

Platynite. G. Flink, 1910. Arkiv Kemi, Min. Geol., vol. iii, No. 35 (Bidrag till Sveriges mineralogi), p. 5 (Platynit). An iron-black metallic mineral found as thin plates at Falun, Sweden. It shows basal and rhombohedral cleavages. Formula $PbS . Bi_2S_2$. Named from πλατύνειν, to flatten.

Poechite. F. Katzer, 1911. Oesterreich. Zeits. Berg- und Hüttenwesen, vol. lix, p. 229 (Poechit). A massive, reddish-brown manganese-iron-ore from Vareš, Bosnia. Analysis gives the formula— $H_{16}Fe_8Mn_2Si_3O_{29}$ or $(MnO)_2SiO_3 . 2(FeO)_2SiO_3 . 5H_2O + 2Fe_2O_3 . 3H_2O$. Named after Franz Poech, Chief of the Department of Mines of Bosnia-Herzegovina.

Poliopyrites. E. F. Glocker, 1839. Grundriss der Mineralogie, 1839, p. 321. An obsolete synonym of marcasite. Named from πολιός, grey, and pyrites; German, Graueisenkies.

Ponite. V. C. Buţureanu, 1912. Ann. Sci. Univ. Jassy, vol. vii, p. 185. A ferriferous variety of rhodochrosite, $5MnCO_3 . FeCO_3$, from Roumania. Named after Petru Poni, Professor of Chemistry at Jassy.

Pouzacite. — Frossard, 1890. [Bull. Soc. Ramond, Bagnères-de-Bigorre.] A. Lacroix, Minéralogie de la France, 1895, vol. i, pp. 383, 384. A variety of clinochlore, identical with leuchtenbergite, occurring in metamorphic limestones at Pouzac, Hautes-Pyrénées.

Preslite. V. Rosický, 1912. Zeits. Kryst. Min., vol. li, p. 521 (Preslit). Synonym of Tsumebite (q.v.). Named in memory of the Bohemian naturalist Jan Swatopluk Presl (1791–1849).

Pseudo-crocidolite. (F. W. Rudler, in T. E. Thorpe's Dictionary of Applied Chemistry, 1890, vol. i, p. 620. L. J. Spencer, The World's Minerals, London and Edinburgh, 1911, p. 156, New York, 1911, p. 202.) Quartz pseudomorphous after crocidolite: the well-known 'tiger-eye' and 'hawk's-eye', from the Asbestos Mountains, Orange River, South Africa, used for ornamental purposes. To replace the misleading trade-name 'crocidolite' often applied to this material.

Pseudoheterosite. A. Lacroix, 1910. Minéralogie de la France, vol. iv, p. 469 (pseudohétérosite). Probably represents a stage in the alteration of triphylite ($Li[Fe,Mn]PO_4$) to heterosite ($[Fe,Mn]PO_4 + H_2O$ (?)). It occurs as a zone between these two minerals, and is detected only by

the difference in optical character as shown in thin sections. From Huréaux, Haute-Vienne.

Pseudo-laumontite. F. F. Grout, 1910. Journ. Geol. Chicago, vol. xviii, p. 654. Hydrous silicate of aluminium, iron, magnesium, and potassium, forming green pseudomorphs after red laumontite in the amygdaloidal diabase of the Keweenawan area, Minnesota.

Pseudo-låvenite. A. Lacroix, 1911. Les syénites néphéliniques de l'archipel de Los et leurs minéraux. Nouv. Arch. Muséum, Paris, ser. 5, vol. iii, p. 60 (Pseudo-låvénite). An undetermined mineral detected in a thin section of the nepheline-syenite of the Los Islands, West Coast of Africa. It resembles låvenite, but differs from this in its optical orientation.

Pseudo-manganite. L. L. Fermor, 1909. Mem. Geol. Survey India, vol. xxxvii, p. lxviii (pseudomanganite), p. 84 (pseudo-manganite). Crystals of manganite altered wholly or partially to pyrolusite.

Pseudo-topaz. A. Sachs, 1910. Centralblatt Min., 1910, p. 498 (Pseudotopas). A crystal from the granite of Striegau, Silesia, which had been described by A. Sachs (ibid., 1909, p. 438) as topaz, was proved by V. Goldschmidt to be merely quartz with a prismatic habit in the direction of one of the horizontal axes. As so orientated there is a remarkable agreement between the interfacial angles of quartz and topaz. In correcting his error, the author adds to the confusion by using the above name.

Pyribole. A. Johannsen, 1911. Journ. Geol. Chicago, vol. xix, p. 319. A contraction of the words pyroxene and amphibole. *See* Biopyribole.

Quercyite. A. Lacroix, 1910. Compt. Rend. Acad. Sci. Paris, vol. cl, pp. 1217, 1388; Minéralogie de la France, vol. iv, p. 579. W. T. Schaller, Bull. U.S. Geol. Survey, 1912, No. 509, p. 92. A type of phosphorite consisting of an intimate interbanded mixture of amorphous (colloidal), optically isotropic collophanite (*see* Fluocollophanite), and a finely fibrous constituent which is optically uniaxial or nearly so. When the crystalline element is optically negative the mixture is called quercyite α, and when optically positive quercyite β. The optically negative constituent corresponds with dahllite ($2Ca_3(PO_4)_2 \cdot CaCO_3 \cdot \frac{1}{2}H_2O$) and staffelite ($(CaF)_2Ca_8(PO_4)_6 \cdot CaCO_3 \cdot H_2O$), but the optically positive constituent does not correspond with any known species. The name quercyite, from Quercy, an ancient district in France noted for its

deposits of phosphorite, is thus a rock name rather than a mineral name. Not to be confused with quercite, the chemical name for 'sugar of acorns'.

Reaumurite. A. Lacroix, 1908. La Montagne Pelée après ses éruptions, Paris, 1908, p. 134; Minéralogie de la France, 1910, vol. iv, p. 778 (réaumurite). Glass when kept for some time at the softening temperature becomes converted into an opaque, white material, the 'porcelain of Réaumur' (René Antoine Ferchault de Réaumur, 1683–1757). This fibrous crystalline material is shown by its optical characters to be orthorhombic, and it has nearly the same composition as glass (approximately $(Ca,Na_2)O \cdot 3SiO_2$). The same substance has been produced under partly natural conditions by the action of volcanic heat on glass vessels in the houses at St. Pierre, Martinique (eruption of Mt. Pelée, 1902), and at Boscotrecase (eruption of Vesuvius, 1906).

Rivaite. F. Zambonini, 1912. Rend. Accad. Sci. Fis. Mat. Napoli, ser. 3, vol. xviii, p. 223; Riv. Min. Crist. Ital., xli, p. 94. A Vesuvian mineral with the formula $(Ca,Na_2)Si_2O_5$. Named after the mineralogist, Dr. Carlo Riva (1872–1902) of Pavia.

Rosieresite. A. Lacroix, 1910. Minéralogie de la France, vol. iv, pp. 532, 399 (rosiérésite). A hydrated phosphate of aluminium containing some lead (PbO 10 per cent.) and copper (CuO 3 per cent.), analysed by P. Berthier in 1841. Found as stalactites in the Rosières copper-mine near Carmaux, Tarn.

Salmonsite. W. T. Schaller, 1912. Journ. Washington Acad. Sci., vol. ii, p. 144. Hydrous manganese and iron phosphate, $Fe_2O_3 \cdot 9MnO \cdot 4P_2O_5 \cdot 14H_2O$, forming buff-coloured cleavable masses, and resulting from the alteration of hureaulite. From the gem-tourmaline mines at Pala, San Diego Co., California. Named after Mr. Frank A. Salmons, formerly of Pala.

Samiresite. A. Lacroix, 1912. Compt. Rend. Acad. Sci. Paris, vol. cliv, p. 1042 (samiresite); Bull. Soc. franç. Min., 1912, vol. xxxv, p. 89 (samirésite). Titano-niobate of uranium, lead, &c., occurring as yellow (altered and hydrated) octahedra in pegmatite at the hill of Samiresy, near Antsirabe, Madagascar. Named after the locality. *See* Betafite.

Shanyavskite. T. A. Nikolaevskij, 1912. Bull. Acad. Sci. St.-Pétersbourg, ser. 6, vol. vi, pp. 717, 724 (Шанявскить). Abstract in Chem. Zentralblatt, 1912, vol. ii, p. 630 (Schaniawskit). A transparent, amorphous, glassy material consisting of almost pure hydrated alumina

($Al_2O_3 . 4H_2O$), occurring with allophanoid minerals in crevices in dolomite near Moscow. Named after A. L. Shanyavskij, of the University of Moscow.

Sheridanite. J. E. Wolff, 1912. Amer. Journ. Sci., ser. 4, vol. xxxiv, p. 476. A pale greenish, talc-like chlorite (near to leuchtenbergite) containing much alumina and very little iron, $H_6Mg_5Al_2Si_2O_{13}$. It occurs as foliated masses in Sheridan Co., Wyoming.

Sicklerite. W. T. Schaller, 1912. Journ. Washington Acad. Sci., vol. ii, p. 145. Hydrous manganese and iron phosphate, $Fe_2O_3 . 6MnO . 4P_2O_5 . 3(Li,H)_2O$, forming dark brown cleavable masses, and resulting from the alteration of lithiophilite. From the gem-tourmaline mines at Pala, San Diego Co., California. Named after the Sickler family, formerly of Pala.

Soda-amblygonite. *See* Natramblygonite.

Soumansite. A. Lacroix, 1910. Minéralogie de la France, vol. iv, p. 541. A fluo-phosphate of aluminium and sodium with some water or hydroxyl; found in small amount as colourless tetragonal crystals on corroded amblygonite from Montebras in Soumans, Creuse.

Sporogelite. M. Kišpatić, 1912. Neues Jahrb. Min., Beil.-Bd. xxxiv, p. 519; F. Tućan, tom. cit., p. 411 (Sporogelit). C. Doelter and E. Dittler, Centralblatt Min., 1913, p. 193. To replace F. Cornu's name α-kliachite (5th list) for the colloidal form of $Al_2O_3 . H_2O$, which occurs as a constituent of bauxite and 'terra rossa'. So named as being the gel corresponding with the crystalloid diaspore. *See* Cliachite and Kljakite.

Stewartite. J. R. Sutton, 1911. Nature, London, vol. lxxxvii, p. 550. A variety of bort, or iron-bort, possessing magnetic properties; from the diamond mines of Kimberley, South Africa. Named after Mr. James Stewart, the manager of the pulsator at the diamond mines.

—— W. T. Schaller, 1912. Journ. Washington Acad. Sci., vol. ii, p. 144. A hydrous manganese phosphate, probably triclinic, occurring as an alteration-product of lithiophilite in the Stewart gem-tourmaline mine, Pala, San Diego Co., California. Named after the locality.

Stichtite. W. F. Petterd, 1910. Catalogue of the Minerals of Tasmania, 3rd edit., Hobart, 1910, p. 167; Papers Roy. Soc. Tasmania, 1910, p. 167. A foliated mineral of a bright lilac colour, which previous to analysis had been mistaken for kaemmererite. A hydrated carbonate

of magnesium, chromium, and iron, $(Cr,Fe)_2O_3 . 6MgO . CO_2 . 13H_2O$. It occurs with chromite as spots and veins in serpentine at Dundas, Tasmania. Named after Mr. Robert Sticht, of Tasmania. Compare chrom-brugnatellite.

Sylvinite. (C. Hintze, Handbuch der Mineralogie, 1911, vol. i, p. 2155 (Sylvinit).) A mining term for the mixtures of sylvite and rock-salt occurring in the Prussian salt-deposits.

Tabbyite. (Mineral Resources, U.S. Geol. Survey, for 1907, 1908, part ii, p. 726.) Trade-name for a solid elastic bitumen from the Uinta basin, Utah. It is closely related to wurtzilite and elaterite.

Tartufite. Venetian mineralogists, before 1812. T. A. Catullo, Manuale Mineralogico, Belluno, 1812, p. 19 (Tartufite). J. Desnoyers, Mém. Soc. Hist. Nat. Paris, 1823, vol. i, p. 179; Ann. Sci. Nat. Paris, 1824, vol. i, p. 58 (Tartuffite). R. Koechlin, Mineralogisches Taschenbuch der Wiener Mineralogischen Gesellschaft, 1911, p. 56 (Tartüffit). A fetid, fibrous calcite from Monte Viale, Venetia, which when struck emits an odour like that of truffles (Italian, tartufo). *See* Truffite (5th List).

Terpitzite. — Dürr [Pastor Dürr died in 1828; this name had been used by him since 1811, but apparently not published]. J. C. Freiesleben, Magazin für die Oryktographie von Sachsen, 1829, Heft iii, p. 168 (Terpizit). A. Frenzel, Mineralogisches Lexicon für das Königreich Sachsen, 1874, p. 274 (Terpitzit). A siliceous sinter (Kieselsinter) passing into hornstone or chalcedony, occurring in crevices in porphyry at Terpitz, Saxony.

Thortveitite. J. Schetelig, 1911. Centralblatt Min., 1911, p. 721 (Thortveitit). Silicate of scandium (yttrium, dysprosium, and erbium), $(Sc,Y)_2O_3 . 2SiO_2$, occurring as long, greyish-green, orthorhombic crystals, somewhat resembling epidote in appearance, in pegmatite near Iveland, Sætersdalen, Norway. Named after Mr. Olaus Thortveit, of Iveland, who sent the material for determination. Remarkable in being the only mineral containing scandium in large amount.

Tolypite. A. Uhlemann, 1909. Min. Petr. Mitt. (Tschermak), vol. xxviii, p. 461 (Tolypit). A name applied to a peculiar structure shown by chlorite from Saxon Vogtland. The mineral has the form of small balls which are built up of irregularly arranged fibres. Named from τολύπη, a ball of thread.

Tsumebite. K. Busz, 1912. Festschrift Gesell. Deutsch. Naturf.

u. Aerzte, Münster, p. 182 (Tsumebit). Hydrated basic phosphate of lead and copper, $5(Pb,Cu)O \cdot P_2O_5 \cdot 8H_2O$, found as small, emerald-green, monoclinic crystals on white calamine at Tsumeb, Otavi, German South-West Africa. *See* Preslite.

Tyuyamunite. K. A. Nenadkevič, 1912. Bull. Acad. Sci. St.-Pétersbourg, ser. 6, vol. vi, p. 945 (тюямунитъ. The French translation of the title on the wrapper gives the form Tïujamunite). Abstract in Chem. Zentralblatt, 1913, vol. i, p. 326 (Tjuiamunit). A hydrated urano-vanadate of calcium, $V_2O_5 \cdot 2UO_3 \cdot CaO \cdot 4H_2O$, occurring with ferganite and turanite (5th list) at Tyuya-Muyun, Fergana, Russian Central Asia. W. F. Hillebrand (Amer. Journ. Sci., 1913, ser. 4, vol. xxxv, p. 440) suggests that it is a calcium carnotite; he spells the name tuyamunite.

Uranopissite. E. F. Glocker, 1847. Generum et specierum mineralium synopsis, p. 74 (Uranopissites, Uranopissit). An obsolete synonym of uraninite or pitchblende. Named from uranium and *πίσσα*, pitch.

Vaterite. W. Meigen, 1911. Verh. Ges. Deutsch. Naturforscher u. Ärzte, 82. Versamml. zu Königsberg, 1910, II. Teil, 1. Hälfte, p. 124 (Vaterit). W. Diesel, Zeits. Kryst. Min., 1911, vol. xlix, p. 272. G. Linck, Doelter's Handbuch der Mineralchemie, 1911, vol. i, p. 113. Vater's third modification of calcium carbonate prepared artificially in the form of minute spherules with specific gravity 2·6 and less stable than aragonite and calcite. Named after Professor Heinrich Vater, of Tharandt, Saxony.

Verdite. Incorrectly given as Vedrite in 5th List.

Vernadskite. F. Zambonini, 1910. Mineralogia Vesuviana. Mem. R. Accad. Sci. Fis. Mat. Napoli, ser. 2, vol. xiv, No. 7, p. 337 (Vernadskijte, Vernadskyte). A green, basic sulphate of copper, $4CuO \cdot 3SO_3 \cdot 5H_2O$, produced by the action of acid vapours from fumaroles on dolerophanite (Cu_2SO_5). Named after Professor Vladimir Ivanovič Vernadsky, of St. Petersburg.

Vilateite. A. Lacroix, 1910. Minéralogie de France, vol. iv, pp. 477, 501 (vilatéite). The violet crystals described by A. Des Cloizeaux (1858) as type I of hureaulite are shown to differ essentially from that species: they give the same qualitative chemical reactions as strengite (hydrated phosphate of iron) with a little manganese. From La Vilate, near Chanteloube, Haute-Vienne.

Viridine. G. Klemm, 1912. [Notizblatt Ver. Erdkunde, Darm-

stadt, for 1911, p. 4]; abstract in Chem. Zentralblatt, 1913, vol. i, p. 54 (Viridin). A green variety of andalusite containing some iron (Fe_2O_3 4·16 per cent.) and manganese (Mn_2O_3 4·77 per cent.) replacing aluminium. It occurs as small grains in a contact-hornfels near Darmstadt. Compare manganandalusite (H. Bäckström, 1896; 1st List). The name viridin has been previously used for chlorophyll; viridine for a coal-tar colour, and viridite for a mineral.

Voelckerite. A. F. Rogers, 1912. Amer. Journ. Sci., ser. 4, vol. xxxiii, p. 479 (Vœlckerite); Zeits. Kryst. Min., 1913, vol. lii, p. 209 (Voelckerit). A basic calcium phosphate, $3Ca_3(PO_4)_2 . CaO$, or oxy-apatite, being a hypothetical member of the apatite group. Named after John Augustus Voelcker, agricultural chemist, whose analyses of Norwegian apatite led him, in 1883, to the formula $3Ca_3(PO_4)_2 . Ca(F_2, Cl_2, O)$.

Vrbaite. B. Ježek, 1912. Rozpravy České Akad., vol. xxi, No. 26; Bull. Intern. Acad. Sci. Prague, vol. xvii, p. 130; Zeits. Kryst. Min., vol. li, p. 364 (Vrbait). A thallium sulpho-salt, $TlAs_2SbS_5$, found as small orthorhombic crystals embedded in realgar and orpiment from Allchar, Macedonia. Named after Professor Karel Vrba, of Prague.

Weibullite. G. Flink, 1910. Arkiv Kemi, Min. Geol., vol. iii, No. 35 (Bidrag till Sveriges mineralogi), p. 4 (Weibullit). This mineral, from Falun, Sweden, was described by M. Weibull in 1885 as a seleniferous variety of galenobismutite, $2PbS . Bi_2S_3 . Bi_2Se_3$. It differs from galenobismutite in possessing distinct cleavages. Named after Professor Mats Weibull, of Alnarp, Sweden.

Wiedgerite. (Mineral Resources, U.S. Geol. Survey, for 1909, 1911, part ii, p. 733; for 1910, 1911, part ii, p. 836 (wiedgerite); Mineral Industry, for 1910, 1911, vol. xix, p. 56 (weidgerite).) Trade-name for a soft bitumen resembling elaterite, but containing much sulphur and water.

Wiltshireite. W. J. Lewis, 1910. Nature, London, vol. lxxxiv, p. 203; Phil. Mag., 1910, ser. 6, vol. xx, p. 474; Zeits. Kryst. Min., 1910, vol. xlviii, p. 514; Mineralogical Magazine, 1912, vol. xvi, p. 197. R. H. Solly, Mineralogical Magazine, 1911, vol. xvi, p. 121. An incompletely determined mineral occurring as small, lead-grey, monoclinic crystals in the crystalline dolomite of the Binnenthal, Switzerland. Probably identical with the rathite of H. Baumhauer (1896). Named in memory of the Rev. Dr. Thomas Wiltshire (1826–1902), formerly Professor of Geology and Mineralogy in King's College, London.

Wolftonite. G. M. Butler, 1913. Economic Geology, vol. viii, p. 8. An oxide of manganese and zinc from the Wolftone mine at Leadville, Colorado. Identical with hetaerolite, $2ZnO \cdot 2Mn_2O_3 \cdot H_2O$ (W. E. Ford and W. M. Bradley, Amer. Journ. Sci., 1913, ser. 4, vol. xxxv, p. 600).

Yttrofluorite. T. Vogt, 1911. Centralblatt Min., 1911, p. 373 (Yttrofluorit). A variety of fluorite containing yttrium earths (17 per cent.); formula $(Ca_3,Y_2)F_6$. Occurs in pegmatite in northern Norway.

Zamboninite. M. Bauer, 1901. Neues Jahrb. Min., 1901, vol. i, Ref. p. 200 (Zamboninit). Synonym of the müllerite of F. Zambonini (1899; 2nd List). The name müllerite (also müllerine and millerite) being preoccupied, the alternative name zamboninite is proposed in an abstract of F. Zambonini's paper.

Zincorhodochrosite. E. Manasse, 1911. Mem. Soc. Toscana Sci. Nat., vol. xxvii, p. 79 (zincorodocroisite). A variety of rhodochrosite containing much zinc (ZnO 31·03 per cent.). From Elba.

Zircon-pyroxenes. W. C. Brögger, 1890. Zeits. Kryst. Min., vol. xvi, p. 363 (Zirkonpyroxene). C. Hintze, Handbuch d. Mineralogie, 1894, vol. ii, pp. 1140, 1176 (Zirkon-Pyroxene, *plur.*). A group-name for the zircono-silicates rosenbuschite, låvenite, wöhlerite, hiortdahlite, &c. Following Brögger, these minerals are usually classified with the pyroxenes, although they do not exhibit prismatic cleavages.

Zittavite. F. Glöckner, 1912. Zeits. Deutsch. Geol. Ges., vol. lxiii, Monatsber., p. 418 (Zittavit). A black, lustrous variety of lignite resembling dopplerite, but more brittle and harder than this. It occurs in the lignite deposits of Zittau, Saxony.

Zoesite. S. Meunier, 1911. Compt. Rend. Acad. Sci. Paris, vol. clii, p. 1879 (zoésite). A variety of fibrous silica (sp. gr. 2·59) isolated by dissolving in acid the fossil shells from the Chalk formation. It differs in its optical orientation from the other forms of fibrous silica (viz. chalcedonite, quartzine, and lutecite). Named from *ζωή*, life, in allusion to the influence of the living organism in producing the fibrous structure. Not to be confused with zoisite.

SYSTEMATIC CLASSIFICATION OF NEW MINERALS.[1]

SULPHIDES, ETC.

Arsenoferrite, $FeAs_2$.
Melnikovite, FeS_2.
Hydrotroilite, $FeS \cdot H_2O$.
Muthmannite, (Ag,Au)Te.
Maucherite, Ni_3As_2.

SULPHARSENITES, ETC.

Vrbaite, $TlAs_2SbS_5$.
Platynite, $PbS \cdot Bi_2S_2$.
Weibullite, $2PbS \cdot Bi_2S_3 \cdot Bi_2Se_3$.
Eichbergite,
$(Cu,Fe)_2S \cdot 3(Bi,Sb)_2S_3$.
Goldfieldite,
$5CuS \cdot (Sb,Bi)_2(S,Te)_3$.

HALOIDS.

Baeumlerite, $KCl \cdot CaCl_2$.
Hydromelanothallite,
$CuCl_2 \cdot CuO \cdot 2H_2O$.
Yttrofluorite, $(Ca_3,Y_2)F_6$.
Mosesite.

OXIDES.

Zoesite, SiO_2.
Haematogelite, colloidal Fe_2O_3.
Guadarramite, var. of ilmenite.
Ferropicotite, $(Fe,Mg)(Al,Fe)_2O_4$.
Ferrobrucite, var. of brucite.
Manganobrucite, ,, ,,
Ferronemalite, ,, ,,
Sporogelite, colloidal $Al_2O_3 \cdot H_2O$.
Shanyavskite, $Al_2O_3 \cdot 4H_2O$.

CARBONATES.

Vaterite, $CaCO_3$.
Calciorhodochrosite, $(Mn,Ca)CO_3$.
Zincorhodochrosite, $(Mn,Zn)CO_3$.
Ponite, $5MnCO_3 \cdot FeCO_3$.
Nicholsonite, var. of aragonite with Zn.
Chrom-brugnatellite,
$7MgO \cdot Cr_2O_3 \cdot 2CO_2 \cdot 12H_2O$.
Stichtite,
$6MgO \cdot (Cr,Fe)_2O_3 \cdot CO_2 \cdot 13H_2O$.
Gajite, Hyd. carb. Ca and Mg.

SULPHATES, ETC.

Bassanite, $CaSO_4$.
Hokutolite, $(Ba,Pb)SO_4$.
Metathenardite, Na_2SO_4.
Millosevichite, Fe''' and Al.
Hexahydrite, $MgSO_4 \cdot 6H_2O$.
Vernadskite, $4CuO \cdot 3SO_3 \cdot 5H_2O$.
Almeriite,
$Na_2SO_4 \cdot Al_2(SO_4)_3 \cdot 5Al(OH)_3 \cdot H_2O$.
Calafatite,
$K_2SO_4 \cdot Al_2(SO_4)_3 \cdot 5Al(OH)_3 \cdot H_2O$.
Beaverite,
$CuO \cdot PbO \cdot Fe_2O_3 \cdot 2SO_3 \cdot 4H_2O$.
Ferritungstite, $Fe_2O_3 \cdot WO_3 \cdot 6H_2O$.
Hinsdalite,
$PbSO_4 \cdot AlPO_4 \cdot 2Al(OH)_3$.

[1] Only the more important names given in the preceding alphabetical list are here included.

Phosphates, etc.

Voelckerite, $3Ca_3(PO_4)_2 . CaO$.
Hydroxyapatite,
$3Ca_3(PO_4)_2 . Ca(OH)_2$.
Quercyite.
Fluocollophanite.
Natramblygonite,
$(Na,Li)Al(OH,F)PO_4$.
Cobaltoadamite, var. of adamite.
Cuproadamite, ,, ,,
Tsumebite,
$5(Pb,Cu)O . P_2O_5 . 8H_2O$.
Palaite, $5MnO . 2P_2O_5 . 4H_2O$.
Stewartite, hyd. phosph. of Mn.
Salmonsite,
$Fe_2O_3 . 9MnO . 4P_2O_5 . 14H_2O$.
Sicklerite,
$Fe_2O_3 . 6MnO . 4P_2O_5 . 3(Li,H)_2O$.
Pseudoheterosite.
Egueiite.
Vilateite.
Soumansite.
Rosieresite.
Flajolotite, $4FeSbO_4 . 3H_2O$.
Tyuyamunite,
$2UO_3 . CaO . V_2O_5 . 4H_2O$.

Niobates, etc.

Ampangabeite.
Betafite.
Samiresite.

Silicates

Barbierite, $NaAlSi_3O_8$.
Cryptoclase, $NaAlSi_3O_8$.
Imerinite, var. of soda-amphibole.
Bababudanite, ,, ,,
Pseudo-låvenite.
Molengraaffite.
Viridine, var. of andalusite.
Thortveitite, $(Sc,Y)_2Si_2O_7$.
Natrodavyne.
Molybdosodalite.
Batchelorite, $H_2Al_2Si_2O_8$.
Sheridanite, $H_6Mg_3Al_2Si_2O_{13}$.
Poechite, $H_{16}Fe_8Mn_2Si_3O_{29}$.
Manandonite, $H_{24}Li_4Al_{14}B_4Si_6O_{53}$.
Minguetite,
$H_{16}(Fe,Al)_8(Fe,Mg)_8(K,Na)_2Si_{17}O_{63}$.
Gageite, $H_4(Mn,Mg,Zn)_8Si_3O_{16}$.
Pilbarite, $H_8ThUPbSi_2O_{14}$.
Epinatrolite.
Arduinite, $H_{16}Na_4CaAl_2Si_8O_{30}$.

Hydrocarbons.

Delatynite, var. of amber.
Albanite, var. of bitumen.
Aeonite, ,, ,,
Aegerite, ,, ,,
Tabbyite, ,, ,,
Wiedgerite, ,, ,,

NOTES.

The following deaths of well-known mineralogists have to be recorded:

George Jarvis Brush (1831–1912), who was elected an honorary member of the Mineralogical Society so long ago as 1879, was best known from his close association with the Sheffield Scientific School of Yale University, New Haven. Entering there in 1848 and graduating in 1852, he for a time acted as assistant in chemistry to Benjamin Silliman, junior, at Louisville, Kentucky, and to J. Lawrence Smith at the University of Virginia. Afterwards, he spent some years studying abroad, at Munich under Liebig and Kobell (1853–4), Freiberg (1854–5), and at the Royal School of Mines in London (1855–6). In 1857 he entered on his duties as Professor of Metallurgy at New Haven, and later this post included also mineralogy. In 1872 he became also Director of the school, retiring as Emeritus Professor in 1898, although still remaining President of the Sheffield Trustees until his death on February 6, 1912. As Professor of Mineralogy he was succeeded by S. L. Penfield. From his boyhood he had collected minerals, and the famous 'Brush Mineral Collection' of about 15,000 specimens was presented, together with a large mineralogical library, to the Sheffield Scientific School in 1904.

Professor Brush's published scientific work had reference mainly to the chemical composition of American minerals. His first paper, giving analyses of albite and indianite, appeared in 1849. The remarkable series of new mineral-species discovered at Branchville, Connecticut, were described in conjunction with E. S. Dana in five papers during the years 1878–1890. He wrote several of the supplements (1860–1872) of J. D. Dana's 'System of Mineralogy', and as a collaborator his name appears on the title-page of the fifth edition (1868) of this indispensable work. His well-known 'Manual of Determinative Mineralogy', which has passed through fifteen editions, first appeared in 1874.

For further biographical details reference may be made to E. S. Dana, Amer. Journ. Sci., 1912, vol. xxxiii, pp. 389–396 (with portrait and bibliography), and W. E. Ford, Science, New York, 1912, vol. xxxv, pp. 409–411.

Konstantin Dmitrievich Khrushchov (C. de Chrustschoff) (–1912) was successful in the artificial preparation of a number of mineral-species, including quartz, tridymite, cristobalite, spinel, zircon, orthoclase, amphibole, diopside, biotite, analcite, and diamond. This work was commenced in Breslau, continued for a time in 1872 at the School of Mines in New York, and again in Breslau until 1890. He had studied also at Leipzig and Heidelberg, but he took his degree of doctor at Breslau; and he had travelled extensively in America. On his return to Russia in 1890 he was attached to the Chemical Laboratory, and afterwards to the Mineralogical Museum of the Imperial Academy of Sciences of St. Petersburg. From 1895 onwards he was Professor of Geology and Mineralogy in the Military-Medical Academy at St. Petersburg.

See Quart. Journ. Geol. Soc., 1913, vol. lxix, pp. lxi–lxii. A detailed summary of his work on artificial minerals (and his portrait, on p. 369) is given by P. Tchirwinsky, 'Reproduction artificielle de minéraux au xix^{e} siècle'. Kieff, 1903–6.

George Augustus Koenig (1844–1913) was born at Willstätt, Baden, and studied at Karlsruhe, Berlin, and Freiberg, graduating at Heidelberg in 1867. In 1869 he migrated to America as a chemist in some chemical works at Philadelphia. In 1872 he became assistant, and in 1875 Professor of Chemistry in the University of Pennsylvania at Philadelphia, and, later, also of Geology and Mineralogy. Since 1892 he was Professor of Chemistry in the Michigan College of Mines at Houghton. His first paper, on a petrographical subject ('Ueber einige Diorite'), was published in Germany in 1868, and he later wrote several papers on American minerals, several of which he described as new species (e. g. bementite).

József Loczka died on March 8, 1912, at the age of 57. For many years he was chemist in the mineral department of the Hungarian National Museum at Budapest. He published the results of many analyses, more especially of minerals from Hungarian localities.

John William Mallet (1832–1912) was born in Dublin, and he took his degree at Trinity College in 1853. He had also studied chemistry at Göttingen under Wöhler, and graduated there in 1852. In 1854 he migrated to America, where he remained for the rest of his life, although he never became a naturalized American citizen. For a time he was chemist on the Geological Survey of Alabama, and afterwards Professor of Chemistry in the University of Alabama. From 1868 until his retirement in 1908 he was Professor of Chemistry in the

University of Virginia, but during that period he held for brief intervals similar posts in the University of Texas and in the Jefferson Medical College at Philadelphia. During the Civil War he was a lieutenant-colonel and superintendent of the ordnance laboratories of the Southern States. He was elected a Fellow of the Royal Society of London in 1877.

Mallet's scientific work related mainly to inorganic chemistry, for example, water analysis and atomic weight determinations of lithium, aluminium, and gold; but he also analysed and described a number of American minerals and meteorites. His first papers, in 1849 and 1850, dealt with Irish minerals, giving an analysis of killinite from near Dublin, and recording the presence of platinum, sapphire, spinel, &c., in the auriferous sands of County Wicklow. He is referred to in many places in Greg and Lettsom's 'Manual of the Mineralogy of Great Britain and Ireland' (1858). See Journ. Chem. Soc., 1913, vol. ciii, pp. 760–763, with portrait.

August Benjamin *Friherre af* (*Baron de*) Schultén (1856–1912) was born at Viborg in Finland. He was an assistant, and since 1881 docent, in chemistry in the university at Helsingfors; and here, in 1881, he presented his inaugural dissertation on the synthesis of analcite. He, however, spent many years abroad, studying at Paris and Heidelberg, and during later years he worked in the laboratories of the Sorbonne at Paris. He prepared artificially a large number of minerals, and also many crystallized compounds of analogous chemical composition to these minerals (e.g. bromo-phosgenite, strontium-apatite, &c.). These were carefully determined crystallographically and their isomorphous relations noted. A small set of these crystallized products was presented by Baron de Schultén to the mineral collection of the British Museum in 1898. A summary of his work (with his portrait on p. 403) has been given by P. Tchirwinsky, 'Reproduction artificielle de minéraux au xix^{e} siècle'. Kieff, 1903–6.

Ferdinand Zirkel (1838–1912), the eminent petrographer, was born and educated at Bonn, where was always his home, and he died there on June 11, 1912. He was Professor of Mineralogy and Geology successively at Lemberg (1863), Kiel (1868), and Leipzig (1870–1909). Although trained as a mining engineer, a trip to Iceland, the Faroe Islands, Scotland, and England, and his meeting with H. C. Sorby, diverted his attention to microscopical petrography, a then new subject which he did so much to develop. His 'Lehrbuch der Petrographie', which first

appeared in 1866 and a second edition in three volumes in 1893–4, is a standard work. Another well-known work is C. F. Naumann's 'Elemente der Mineralogie', of which Zirkel prepared the eleventh to fifteenth editions (1877–1907). He was an honorary D.Sc. of Oxford and a Foreign Member of the Royal Society, and he was elected an honorary member of the Mineralogical Society in 1879. Of the several obituary notices that have appeared, reference may be made to that by Professor R. Brauns, Centralblatt Min., 1912, pp. 513–521, with portrait and bibliography.

The following is the text of the address which was presented by the President of the Mineralogical Society on the occasion of the 250th anniversary of the Royal Society, celebrated in July of last year:

SOCIETAS MINERALOGICA
SOCIETATI REGALI
S.P.D.

GRATULAMUR SOCIETATI vestrae quod annos ducentos et quinquaginta ab origine vestra feliciter peractos mox estis celebraturi. Simul maximas gratias agimus quod scientias illas quae ad terrae structuram mineralem pertinent auxilio vestro et hortatione semper fovistis.

(*Signed*) *W. J. Lewis*
Praeses

Datum LONDINI
die xviii mensis Junii
MCMXII

W. P. Beale
Thesaurensis

George T. Prior
Secretarius

Amongst noteworthy recent additions to the Mineral Collection of the British Museum is the collection of minerals formed by the British naturalist Thomas Pennant (1726–1798), which has been presented in 1913 by the Earl of Denbigh, and described in some detail in the preceding pages by Mr. W. Campbell Smith. A few of the better specimens of more general interest have been selected for incorporation in the general collection of minerals; these are at present displayed in the recent addition case in the Mineral Gallery at South Kensington. The bulk of the collection has, however, been preserved intact in the original oak cabinet and arranged in the same order as it was left by Pennant. In this form it is of considerable historic interest, as illustrating a natural history system of classification in vogue in the eighteenth century, before the development of the sciences of crystallography and chemistry.

Another collection, also of interest partly on account of its historic associations, is the extensive collection of foreign and colonial rocks and minerals which, together with that of fossils, has been presented by the Geological Society of London to the Trustees of the British Museum. These were transferred in June 1911, and are now available for reference at South Kensington. By far the larger part of the collection consists of rock-specimens, about 17,000 in number, and belonging to some 400 different topographical collections. These topographical collections are in many cases illustrative of papers published in the Society's Transactions and Quarterly Journal, and having been collected and described by Lyell, Scrope, De la Beche, Murchison, and other pioneers in the study of geology, they are of considerable historic interest. Of these older collections, the following may be mentioned: specimens from the Faroe Islands described in 1821 by Sir W. C. Trevelyan, Bart.; a collection from Normandy described in 1824 by Sir H. T. De la Beche; a large series from Auvergne collected and described in 1827 by G. P. Scrope; and another collection from the same region collected and described in 1828 by Sir C. Lyell and Sir R. I. Murchison; collections from the Italian volcanic districts made by Scrope in 1823–4; a series from Greenland collected by C. L. Giesecke.

The time of the meetings of the Society was altered some few years ago (in 1909) from 8 o'clock in the evening to 5.30 o'clock in the afternoon. That this change has been an advantage is shown by the increased attendance; the average number of members and visitors present at the ten meetings preceding the change being 24·5, and at the ten meetings

after the change 30·6. At the conclusion of these earlier meetings it has become the custom for the members and their friends to dine together at some neighbouring restaurant, where matters, mineralogical or otherwise, can be discussed in an informal manner, and mineralogists are afforded an opportunity of becoming more closely personally acquainted. There has been no tendency for this arrangement to develop into an exclusive dining-club; every member, whether a new member or from a distance, is welcome. This note in the Magazine may help to make this more generally known, and inquiry at the meeting will elicit what arrangements have been made for dining together on the particular evening.

Professor Victor Goldschmidt holds a unique position in our Society, being an ordinary life member and also an honorary member. His sixtieth birthday (on February 10, 1913) and the jubilee (25 years) of his Dozentship were made the occasion of a festive gathering at Heidelberg on February 8 and 9 last, when he was presented with an album of the portraits of his old pupils and mineralogical friends. Our congratulations may also be extended to Professor Goldschmidt on the appearance of the first volume of his important work 'Atlas der Krystallformen', an elaborate prospectus of which has been circulated by the publishers.

REVIEWS.

The Petrology of the Sedimentary Rocks. A description of the sediments and their metamorphic derivatives. By F. H. Hatch and R. H. Rastall. With an appendix on the systematic examination of loose detrital sediments, by T. Crook. Pp. xiii + 425, with 60 text-figures. (London: G. Allen & Co., 1913. Price 7*s.* 6*d.* net.)

This is a companion volume to Dr. Hatch's well-known 'Text-book of Petrology' (treating of the igneous rocks alone), the fifth edition of which was reviewed in these pages in 1909. On the half-title of the present book appears 'Text-book of Petrology, vol. ii'. In view of the little attention that has hitherto been given in textbooks to the sedimentary rocks, this volume will prove to be of much use, not only to the student working for examinations, but also to other workers. The matter is, however, not treated on the same lines as in Dr. Hatch's previous volume, and rather than being a descriptive petrography of the sedimentary rocks, it is more a dissertation on petrogenesis. Further, so much latitude is given to the term metamorphism that practically every rock, except a freshly deposited sediment, would appear to be metamorphic; and the title of the book might well have been 'The origin of metamorphic rocks'. Part I (pp. 3–145) deals with the various forms of sediments—fragmental, chemical, and organic; and Part II (pp. 149–338) with the various metamorphic processes—cementation and metasomatism, contact metamorphism, regional metamorphism, and weathering. Useful tables, showing the relations between the different kinds of rocks, are given on pp. 160 and 220. The book is thus not well adapted to the needs of a reader who requires definite information about the lithological and petrographical characters of, say, sandstone or limestone. Not the least valuable portion is the Appendix (pp. 339–414), which gives in detail the practical methods for determining the mineralogical composition of loose detrital sediments, and especially of the concentrates of heavy minerals obtained by panning.

Mineralogy: an introduction to the theoretical and practical study of minerals. By Alexander Hamilton Phillips. Pp. viii + 699, with 534 text-figures. (New York: The Macmillan Company, 1912. Price $3.75 = 16*s.* net.)

In format and general appearance this book bears a strong resemblance to Miers's well-known 'Mineralogy: an introduction to the scientific study of minerals', issued by the same publishers just ten years before. Of the two, we distinctly prefer Miers, although the new book has the advantage in being lower in price. The treatment of the subject is much the same as in Miers, although rather more elementary in character. It is dealt with in three parts: Crystallography, Descriptive Mineralogy, and Determinative Mineralogy, the last including 90 pages of determinative tables. Many of the illustrations are half-tone photographic reproductions of actual specimens, but only few of them adequately represent the minerals portrayed. Several misprints have been noticed in the text.

Guide to the Collection of Gemstones in the Museum of Practical Geology. By W. F. P. McLintock. Pp. iv + 92, with 43 text-figures. (London: H. M. Stationery Office, 1912. Price 9*d.*)

At the very moderate price of ninepence this is quite the cheapest textbook on gem-stones that has yet been given to the public. The treatment is general, and apart from the references to the cases where the specimens are exhibited, it would apply, as a guide, to any collection of gem-stones. The subject is treated in a thorough, yet elementary, manner, giving firstly (Chapters I–III, pp. 4–34) a general account of the properties of gem-stones, the forms employed for their cutting, and their imitation and artificial production; and secondly (Chapter IV, pp. 35–87) a description of each kind of stone. An appendix compares in tabular form the essential characters of different stones of the same colours. There are a few misprints and minor errors, some of which should not have escaped the notice of the press-reader.

Geologische Diffusionen. By Raphael E. Liesegang. Pp. vii + 180, with 44 text-figures. (Dresden and Leipzig: Th. Steinkopff, 1913. Price 5 Marks, unbound; 6 Marks, bound.)

In this book the author has brought together the results of all his work on diffusion in relation to geology, and has reviewed the work of most recent investigators in this subject.

The preliminary discussion involves a summary of recent work on the behaviour of colloids, and a consideration of the media in which diffusion can take place. It appears that while diffusion takes place in aggregates of crystals, it cannot do so in a uniform individual crystal. The apparent exceptions to this rule are considered. The principles of diffusion are illustrated by thirty-three experiments, most of them original, and the

applications of the principles to numerous phenomena are treated in separate chapters. These phenomena include the formation of various concretions, the secondary enrichment and lateral secretion of ores, and numerous banded structures in minerals and rocks. All are phenomena with which geologists are perfectly familiar, but of which the explanation has been only vaguely stated. An important chapter is one dealing with the origin of gold deposits, reviewing the work of Hatschek and Simon and of others.

The banded structures depend on the properties of supersaturated solutions, as was suggested by Wilhelm Ostwald in 1899. Chapter XI, explaining the diffusion theory of agate structures, summarizes Liesegang's well-known work in this direction. The origin of banded flints is discussed in Chapter XV. These were at one time regarded as of organic origin. One of the first papers pointing out their inorganic origin was that of S. P. Woodward in 1864, describing the specimens in the British Museum, to which, however, no reference is found in this place.

Among other structures which are considered are 'Eozoon', the ore-pipes of Pitkäranta, and the colour-bands in marl. The subject of 'Eozoon' always arouses interest. The explanation of its banded structures in the light of the diffusion theory is made fully convincing in an admirably illustrated review of Trüstedt's work on the metamorphosed limestones of Hopunwaara, Finland. A reference to the paper by Johnston-Lavis and Gregory on 'The Eozoonal structures in the ejected blocks of Monte Somma' might well have found a place in this chapter. The explanation of the origin of the silicate minerals in metamorphosed limestones leads to a discussion of the diffusion of silicic acid in dolomite, and of the possibility of its being derived directly from intrusive granite. In this connexion the important paper by Hatch and Rastall on 'The dedolomitisation of the Port Shepstone marble' is quoted. The view that certain constituents can diffuse from an intrusive magma into a limestone is strongly supported by a paper, by Adams and Barlow, on 'The Geology of the Haliburton and Bancroft areas, Ontario', dealing with the origin of the 'ophicalcites' in that district.

The book closes with a glance at the wider problems of geology to which the principles of diffusion may be applied, and though he has touched only lightly on many problems, the author has shown that diffusion is a factor of great importance in geology and mineralogy, and one to which we can look for the explanation of many hitherto obscure phenomena.

W. C. S.

INDEX TO VOL. XVI.

(See also 'List of New Mineral Names', p. 352.)

Absorption-brushes, 11.
— -figures, 11.
— -polarization, 3.
Allophane from Co. Galway, 273.
Ammonium magnesium chromate, 170.
Anatase from Binn, Switzerland, 290.
— from Cornwall, 49.
Angles, graphical determination, 326.
Ankerite in coal, 219.
Apatite from Lundy Island, 299.
Apparatus, lapidary's, 317.
— universal, 100.
Arizona, mineralogy of, 73.
Artificial crystals of calcite, 345.
Autunite from Cornwall, 50.
Axial-angle apparatus, 104.

Balance-sheet, xxv, xxxiii, xli.
Baret (C.), obituary, 156.
Barker (T. V.), inosite, potassium nitrate, and urea nitrate, 207.
— mercuric iodide, xxxii.
Barytes in coal, 222.
— optical extinction, 232.
Bayley (W. S.), Crystallography (review), 74.
Bell (R.), elected member, xxxv.
Bemmelen (J. M. van), obituary, 159.
Bertrandite from Cornwall, 47.
Beryl from Lundy Island, 298.
Binnenthal minerals, xxvii, xxxi, xxxv, 121, 197, 282, 287, 290, 343.
Blake (G. S.), zirkelite from Ceylon, 309.
Blake (W. P.), obituary, 157.
Borlase (W.), 336.
Bowman (H. L.), bertrandite from Cornwall, 47.
— models to illustrate theories of crystal structure, 51.
— & Clarke (H. E.), Dokáchi meteorite, 35.
Brauns (R.), The Mineral Kingdom (review), 254, 307.
— Die kristallinen Schiefer des Laacher Seegebietes (review), 167.
Breccias, 124.
Brecciation of mineral-veins, 124.
British minerals, 30, 47, 55, 63, 125, 217, 219, 264, 272, 294, 306, 331.
Brush (G. J.), obituary, 379.
Büschel, 11.
Building stones, 165.
Burkitt (M.), elected member, xxx.
Butler (F. H.), natural history of kaolinite, 63.
— brecciation of mineral-veins, 124.
Bye-laws, vii.

Caesium magnesium chromate, 182.
Calamine ($ZnCO_3$) from Flintshire, 339.
Calcite in coal, 221.
— from a water-tank, 345.
— from New York, 166.
Calderón (S.), Los Minerales de España (review), 72.
— obituary, 247.
Carbonado, large mass, 145, 394.
Cassiterite (wood-tin), 30.
— from Malay, 118, 302.
Ceylon, zirkelite, 309.
Chapman (M. B.), analysis by, 345.
Chemical analysis of meteorites, 38.
— — of rocks, 75.
China-clay, 67.
Chromates of alkalis and magnesium, 169.
Chrustschoff (C. de), obituary, 380.
Clark (R. W.), Petrographic Methods (review), 304.
Clarke (F. W.), elected hon. member, xxxviii.
— Data of Geochemistry (review), 250.
Clarke (H. E.) & Bowman (H. L.), Dokáchi meteorite, 35.
Classification of minerals, 333.
Clinohedral class, 87.
Coal, ankerite in, 219.
Colemanite (neocolemanite), 239.
Collections, 251, 252, 331, 383.
Collingridge (H.), elected member, xxxviii.

Collingridge (H.), determination of optic axial angles in thin-section, 348.
Collins (J. H.), wood-tin, 30.
Coon (J. M.), china-clay, xxiii.
Copalite from Richmond, 338.
Cornish minerals, 30, 47, 55, 68, 125, 217.
Costa (E. M. da), 336.
Crook (T.), pleochroism and idiophany, 1.
— electrostatic separation of minerals, 109.
— ankerite in coal, 219.
— & Johnstone (S. J.), strüverite from Malay, 224.
— Examination of Loose Sediments (review), 385.
Crush-breccias, 126.
Crystal groups, 254.
— structure, 254.
— — models, 51.
Crystalline schists, 167.
Crystals, growth and solution of, 74.

Dana's Manual of Mineralogy (review), 304.
Determinative tables, 166.
Deutsche Mineralogische Gesellschaft, 249.
Diagram, total-reflection, 236.
Diamond, crystallogr., 164.
Diamonds, large, from S. Africa, 140.
Dinner after meetings, 384.
Diopside from El Nakhla meteorite, 276.
Doelter (C.), Handbuch der Mineralchemie (review), 161.
Dokáchi meteorite, 35.
Drugman (J.), elected member, xxii.
— quartz twinned on the primary rhombohedron, 112.
Dufrenoysite, 284.
Dundasite from Derbyshire and Co. Galway, 272.
Duparc (L.) & Monnier (A.), Traité de Minéralog. et Pétrogr. (review), 307.

Editorial committee, xxxviii.
El Nakhla meteorite, 274.
Electrostatic separation of minerals, 109.
Emmons (S. F.), obituary, 157.
Epoptic figures, 28.
Eppler (A.), Die Schmuck- und Edelsteine (review), 306.
Eutropic series, 195.
'Excelsior' diamond, 140.
Exchanges of publications, xx.
Extinction-angles, graphic method for determining, 232.

Fedorov's setting, 208.
Felspar from Lundy Island, 299.
Fermorite, 84.
Fersmann (A. von) & Goldschmidt (V.), Der Diamant (review), 164.
Fissure-breccias, 127.
Fleischmann (F. N. A.), elected trustee, xxxi.
Fletcher (L.), 251.
— portrait of, xxiv.
Fletcher (M.), artificially-produced crystals of gypsum, 137.
Flintshire minerals, 338.
Fluor-spar from Cornwall, 49, 60.
— from Flintshire, 339.
— from Lundy Island, 299.
Ford (W. E.), Dana's Manual of Mineralogy (review), 304.
Fortschritte der Mineralogie, 249.
France, mineralogy of, 71.
Friedel (G.), Cristallographie (review), 163.

Galena in coal, 221.
Gardiner (C. R.), elected member, xxxi.
Gemstones, 306, 386.
Geochemistry, 250.
Geological Society's collection, 383.
German Mineralogical Society, 249.
Goldschmidt (V.), elected hon. member, xxxii.
— jubilee, 384.
— & Fersmann (A. von), Der Diamant (review), 164.
Goniometer, universal, 100.
Granite of Lundy Island, 295.
Graphic determination of extinction-angles, 232.
— — of angles and indices, 326.
— — of optic axial angles, 348.
'Great white' diamond, 143.
Greenockite from Derbyshire and Wanlockhead, 272.
Groth (P. von), 250.
— Physical Crystallography (review), 163.
Growth of crystals, 167.
— and solution of crystals, 74.
Guild (F. N.), Mineralogy of Arizona (review), 73.
Gunther (C. G.), Mining Geology (review), 305.
Gwinnell (R. F.), calcite crystals from a water-tank, 345.
Gypsum, artificial crystals, 137.
— temperature of optical uniaxiality, 257.

Halite, growth of, 74.
Hall (T. C. F.), elected member, xxiv.
— & McLintock (W. F. P.), topaz and beryl from Lundy Island, 294.
Hallimond (A. F.), elected member, xxxv.
Harker (A.), tables for calculation of rock-analyses, 75.
Hatch (F. H.) & Rastall (R. H.), Petrology (review), 385.
Hatchite, 287.
Hatschek (E.), growth of crystals in gels, xxxii.
Henson (F.), elected member, xxii.
Heslop (M. K.), elected member, xxii.
Hoff (J. H. van 't), obituary, 160.
Houppes, 11.
Houston (R. S.), Mineralogy of Renfrewshire (review), 306.
Hunt (W. F.) & Kraus (E. H.), Determinative Tables (review), 166.
Hussak (E.), obituary, 247.
Hutchinson (A.), universal goniometer, 100.
— total-reflection diagram, 236.
— identity of neocolemanite with colemanite, 239.
— & Smith (W. C.), sericite from North Wales : penninite and labradorite from Ireland, 264.
— & Tutton (A. E. H.), temperature of optical uniaxiality in gypsum, 257.

Iddings (J. P.), Rock Minerals (review), 164.
Idiocyclophany, 28.
Idiophany and pleochroism, 1.
Ilmenite from Binn, Switzerland, 343.
'Imperial' diamond, 143.
Indices, graphical determination, 326.
Inosite, 207.
International Catalogue of Scientific Literature, xxviii.
Iodate of lead, 82.
Irish minerals, 264, 272, 338.
Isomorphous sulphates and chromates, 169.

Jackson (B. H.), Optical Properties of Crystals (review), 163.
Johnsen (A.), Wachstum und Auflösung der Kristalle, 74.
Johnstone (S. J.) & Crook (T.), strüverite from Malay, 224.
Journal to members, xxxv.
'Jubilee' diamond, 142.

Kaolinite, origin of, 67.
— from Derbyshire, 70.
— from Glamorganshire, 63.
Kaolinization, 65, 300.
Khrushchov (K. D.), obituary, 380.
Koenig (G. A.), obituary, 380.
Kohlrausch total-reflectometer, 105.
Kotō (B.), elected member, xxxviii.
Kraus (E. H.) & Hunt (W. F.), Determinative Tables (review), 166.
Kreutz (F. F. X.), obituary, 158.

Labradorite from Co. Down, 267.
Lacroix (A.), Minéralogie de la France (review), 71.
Lapidary's apparatus, 317.
Leo (M.), Anlauffarben (review), 73.
Lévy (A. M.), obituary, 248.
Lewis (W. J.), rathite and its variety wiltshireite, 197.
— ilmenite from Binn, 343.
— liveingite (?), xxxi.
Liesegang (R. E.), Geological Diffusions (review), 386.
Light-figures, 80, 165.
Loczka (J.), obituary, 380.
Luedecke (O. P.), obituary, 158.

McLintock (W. F. P.), Guide to Collection of Gemstones (review), 386.
— & Hall (T. C. F.), topaz and beryl from Lundy Island, 294.
Macnair (P.), study of rocks, 76.
Magnetic cassiterite, 110, 118.
Malay, minerals from, 110, 118, 224, 302.
Mallet (J. W.), obituary, 380.
Maskelyne (N. S.), *see* Story-Maskelyne.
Meetings, time of, 383.
Members, list of, xi.
Mendipite, 337.
Meteorite, Dokáchi, 35.
— El Nakhla, 274.
Mica, pseudo-absorption, 13.
— pseudo-pleochroism, 7.
— from Lundy Island, 299.
Michel-Levy (A.), *see* Lévy (A. M.).
Microchemical tests, 73.
Miers (Sir H. A.), 251.
— elected trustee, xxviii.
— The Growth of a Crystal (review), 167.
Mineral chemistry, 161.
Mineral-veins, brecciation of, 124.
Mineralogisches Taschenbuch der Wiener Mineral. Gesell. (review,) 75.

Minerals, new names, 352.
Models of crystal structures, 51.
Monnier (A.) & Duparc (L.), Traité de Minéralog. et Pétrogr. (review), 307.
Morgan (A. H.), elected member, xxxvi.
Moriogram, 326.

Names, new mineral, 352.
Natrolite from Cornwall, 218.
Neocolemanite = colemanite, 239.
Nickel-iron from Dokáchi meteorite, 41.
Nitrogen sulphide, 97.
Notes, 247, 379.

Obituaries :—
Baret (C.), 156.
Bemmelen (J. M. van), 159.
Blake (W. P.), 157.
Brush (G. J.), 379.
Calderón (S.), 247.
Emmons (S. F.), 157.
Hoff (J. H. van 't), 160.
Hussak (E.), 247.
Khrushchov (K. D.), 380.
Koenig (G. A.), 380.
Kreutz (F. F. X.), 158.
Lévy (A. M.), 248.
Loczka (J.), 380.
Luedecke (O. P.), 158.
Mallet (J. W.), 380.
Petterd (W. F.), 159.
Philippi (E.), 159.
Schultén (A. B. de), 381.
Spezia (G.), 248.
Story-Maskelyne (M. H. N.), 149.
Törnebohm (A. E.), 248.
Ussing (N. V.), 249.
Wurtz (H.), 160.
Zirkel (F.), 381.
Olivine from El Nakhla meteorite, 277.
Opaque minerals, 73.
Optic axial angles, determination in thin-section, 348.
Optical uniaxiality in gypsum, 257.
Ores, tarnish on, 73.

Pennant (T.), collection, 331, 383.
Penninite from Co. Galway, 266.
Petterd (W. F.), obituary, 159.
Phenacite from Cornwall, 55.
Philippi (E.), obituary, 159.
Phillips (A. H.), Mineralogy (review), 385.
Phlogopite, pseudo-absorption, 13.
Pleochroism and idiophany, 1.
Pneumatolysis, 67.
Point-systems, 51.
Polarization-brushes, 11.
Pontoppidan (E. L.), 336.
Porter (M. W.) & Tutton (A. E. H.), double chromates, 169.
Potassium nitrate, 210.
Precious stones, 306, 386.
Prehnite from Cornwall, 217.
President, office of, xxxv.
Prior (G. T.), 251.
— El Nakhla meteoric stone, Egypt, 274.
— & Smith (G. F. H.), Schwartzembergite, 77.
— — fermorite and tilasite from India, 84.
Pseudo-absorption, 13.
Pseudomorphs, 119, 339.
Pseudo-pleochroism, 7.
Publications, exchanges, xx.
Pyromorphite from Flintshire, 339.
Pyrrhotite, large crystal, 252.

Quartz twins, 112.
— from Lundy Island, 298.

Rastall (R. H.) & Hatch (F. H.), Petrology (review), 385.
Rathite, 121, 197.
Rathite *a*, 121.
Reflectometer, total-, 105.
Refractometer, 107.
— diagram, 236.
'Reitz' diamond, 142.
Report of Council, xxiii, xxix, xxxvii.
Reviews of books, 71, 161, 253, 304, 385.
Rhodochrosite from Shropshire, 338.
Rock-analyses, 75.
Rocks, study of, 76.
— thin-sections, 317.
Rogers (A. F.), elected member, xxxviii.
— Study of Minerals (review), 305.
Royal Society 250th anniversary, xxxii, 382.
Rubidium magnesium chromate, 177.
Russell (A.), phenacite in Cornwall, 55.
— prehnite from Cornwall, 217.
— dundasite from Derbyshire and Co. Galway, 272.
— Shropshire minerals, xxxii.
— Montgomeryshire minerals, xl.
Russian minerals, 72.

Sanidinite, 167.
Savigar (G.), Bibliography of N. Story-Maskelyne, 152.
Scandium in strüverite, 229.
Schaller (W. T.), elected member, xxxvi.

Schists, 167.
Schultén (A. B. de), obituary, 381.
Schwartzembergite, 77.
Scrivenor (J. B.), cassiterite from Malay, 118.
— strüverite in Perak, 302.
Seligmannite, 282.
Separation, electrostatic, 109.
Sericite from North Wales, 264.
Shot-tin, 31.
Simpson (E. S.), elected member, xxxvi.
Smith (G. F. H.), crystalline form of nitrogen sulphide, 97.
— anatase from Binn, Switzerland, 290.
— apparatus for preparing thin-sections of rocks, 317.
— graphical determination of angles and indices, 326.
— & Blake (G. S.), zirkelite from Ceylon, 309.
— & Prior (G. T.), Schwartzembergite, 77.
— —fermorite and tilasite from India, 84.
— & Solly (R. H.), hatchite, a new mineral, 287.
Smith (H. G.), elected member, xxviii.
— graphic method for determining extinction-angles, 232.
Smith (W. C.), mineral collection of T. Pennant, 331.
— & Hutchinson (A.), sericite from North Wales : penninite and labradorite from Ireland, 264.
Societies, xx.
Sohncke point-systems, 51.
Solly (R. H.), rathite, rathite α, and wiltshireite, 121.
— seligmannite and dufrenoysite, 282.
— Binnenthal minerals, xxvii, xxxv.
— & Smith (G. F. H.), hatchite, a new mineral, 287.
Solution and growth of crystals, 74.
Sommerfeldt (E.), Die Kristallgruppen (review), 254.
Space-lattices, 51.
Spain, minerals of, 72.
Spencer (L. J.), larger diamonds of South Africa, 140.
— obituary of N. Story-Maskelyne, 149.
— list of new mineral names, 352.
— Brauns's Mineral Kingdom (review), 254, 307.
— crystallogr. determinations, 56, 217.
— International Catalogue Sci. Lit., xxviii.
Spezia (G.), obituary, 248.
Story-Maskelyne (M. H. N.), obituary, 149, 394.
Strüverite from Malay, 224, 302.

Tarnish on ores, 73.
Tendron (F.), collection of minerals, 252.
Text-books, 74, 161, 250, 304, 385.
Thin-sections of rocks, 317.
— determination of optic axial angles in, 348.
Tilasite from India, 86.
— from Sweden, 95.
Topaz from Lundy Island, 296.
Topographical mineralogies, 71, 72, 73, 306, 331.
Torbernite from Cornwall, 49.
Törnebohm (A. E.), obituary, 248.
Total-reflection diagram, 236.
Total-reflectometer, 105.
Tourmaline from Lundy Island, 299.
Tourmalinization, 67.
Tutton (A. E. H.), elected president, xxxvi.
— Crystallography (review), 162.
— & Hutchinson (A.), temperature of optical uniaxiality in gypsum, 257.
— & Porter (M. W.), double chromates, 169.
Twinning of quartz, 116.

Universal goniometer, 100.
Urea nitrate, 212.
Ussing (N. V.), obituary, 249.

van 't Hoff (J. H.), obituary, 160.
Vein-breccias, 124.
Vernadsky (V. I.), Descriptive Mineralogy (review), 72.
'Victoria' diamond, 143.
Vienna Mineralogical Society, 75.
Viola (C.), elected hon. member, xxxii.
Voigt (W.), Lehrbuch der Kristallphysik (review), 253.
Volcanic breccias, 124.

Wales, minerals of, 63, 338.
Walker (I.), collection of minerals, 251.
Wallerant (F.), elected hon. member, xxxviii.
Watson (J.), Building Stones (review), 165.
Weinschenk (E.), Petrographic Methods (review), 304.

Whitlock (H. P.), Calcites of New York (review), 166.
Wiltshireite, 121, 197.
Winchell (A. N.), Optical Minerogy (review), 250.
Wood-tin, 30.
Wurtz (H.), obituary, 160.
Xenotime from Malay, 110.
Zeitschrift für Krystallogr., 250.
Zinc-blende in coal, 221.
Zirkel (F.), obituary, 381.
Zirkelite from Ceylon, 309.

ERRATA.

VOL. V.

Page.	Line.	
53	2*	*For* $2R_2O$, *read* $2R_2O_3$.

VOL. XII.

384	14*	*For* XII, *read* vol. XI.

VOL. XIII.

329	5*	*For* Bindon, *read* Bindon House in the parish of Langford Budville, west of Taunton.

VOL. XIV.

341	6*	*For* (no. 83989), *read* (no. 83979).

VOL. XV.

xxxiv	8	*For* Friederich, *read* Friedrich.
24 25 (fig. 6)	1	*For* $g\ \{\bar{2}11\}$, *read* $g\ \{\bar{2}21\}$.
24 (Table of angles)		*For* cs = (001) : ($\bar{1}$02) 42° 0′, *read* 41° 50′.
,,	,,	*For* gf = ($\bar{2}$11) : ($\bar{1}$01) 43° 37′, *read* gf = ($\bar{2}$21) : ($\bar{1}$01) 43° 58′.
420	20	*For* in nepheline-syenite, *read* in crystalline limestone at contact with nepheline-syenite.
424	6*	The author of the name 'Lublinite' is J. Morozewicz (1907); N. S. Watitsch appears as the author of a long résumé of Morozewicz's paper (see this vol., p. 364).
433	17	*For* Vedrite, *read* Verdite.
437	—	*Under* Farrington (O. C.), *add* Phosphorus (1903).
438	—	*Add* Gautier (A.), Minervite (1893).
,,	—	*Add* Howe (H. M.), Cementite (1890), Ferrite (1890).
439	—	*Dele* Osmond (F.), Cementite (1895).
,,	—	*Add* Luzi (W.), Graphitite (1891).
,,	—	*Under* Morozewicz (J.), *add* Lublinite (1907).
441	—	*Dele* Vatič *and* Watitsch.
448	—	*Under* Bowen (D.), *for* xxvii, *read* xxviii.

* From bottom of page.

VOL. XVI.

Page.	Line.	
145	18	*For* rccent, *read* recent.
,,	—	(foot-note 1) *Add as the earliest reference* : H. Moissan, Compt. Rend. Acad. Sci. Paris, 1895, vol. cxxi, p. 449, where the weight of the largest known mass of carbonado is given as 630 grams = 3073 carats of 205 milligrams.
154	—	*Add* to Bibliography of N. Story-Maskelyne : 1874 [Ueber Isomorphie von Asmanit und Brookit.] (Letter to Prof. G. vom Rath) Zeits. Deutsch. geol. Gesellsch., vol. xxvi, p. 927.
166	2*	*For* monography, *read* monograph.
251	—	(foot-note 2) *For* 1833–6, *read* 1834–9.

* From bottom of page.